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GB A 2131816

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GB A 2122627

EP A2 0056005

GB 1552928

EP A2 0027375

GB 1467463

US 4178328

GB 1422561

US 4111895

GB 1359740

US 4079099

EP A1 0114964

US 3865776

(58) Field of search

C3M

C3V

(54) Polyolefin-containing extrudable compositions and methods for their formation into elastomeric products

(57) Extrudable elastomeric compositions are formed by blending from at least 10 percent, by weight, of an A-B-A' block copolymer where "A" and "A'" are each a thermoplastic endblock which includes a styrenic moiety and where "B" is an elastomeric poly(ethylene-butylene) midblock with up to about 90 percent, by weight, of at least one polyolefin which, when blended with the A-B-A' block copolymer and subjected to an effective combination of elevated temperature and elevated pressure conditions, is adapted to be extruded in blended form, with the A-B-A' block copolymer. Fibrous nonwoven elastomeric webs and elastomeric films and processes for forming them are disclosed.

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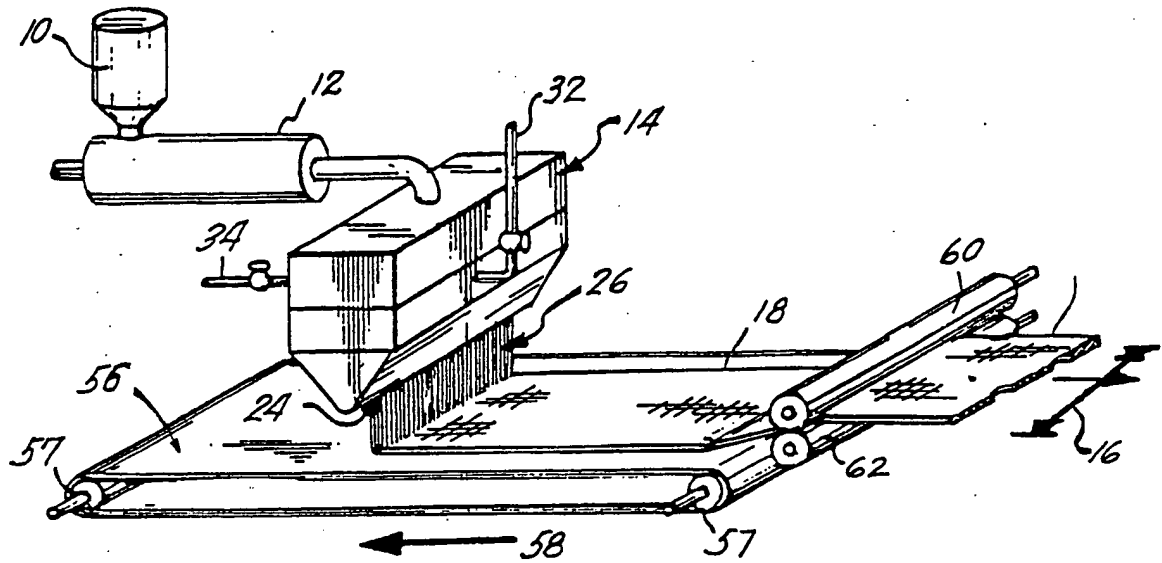


FIG. 1

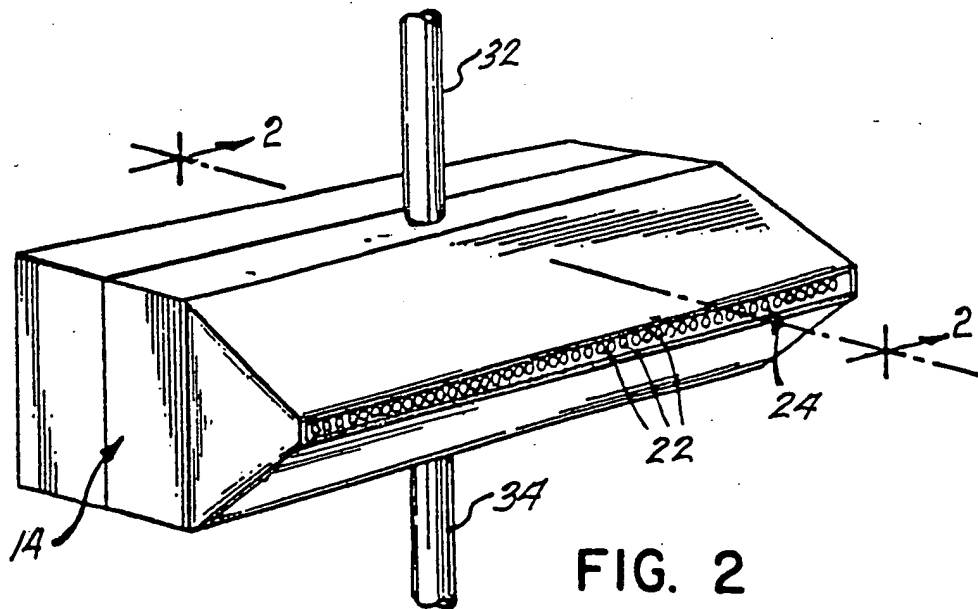


FIG. 2

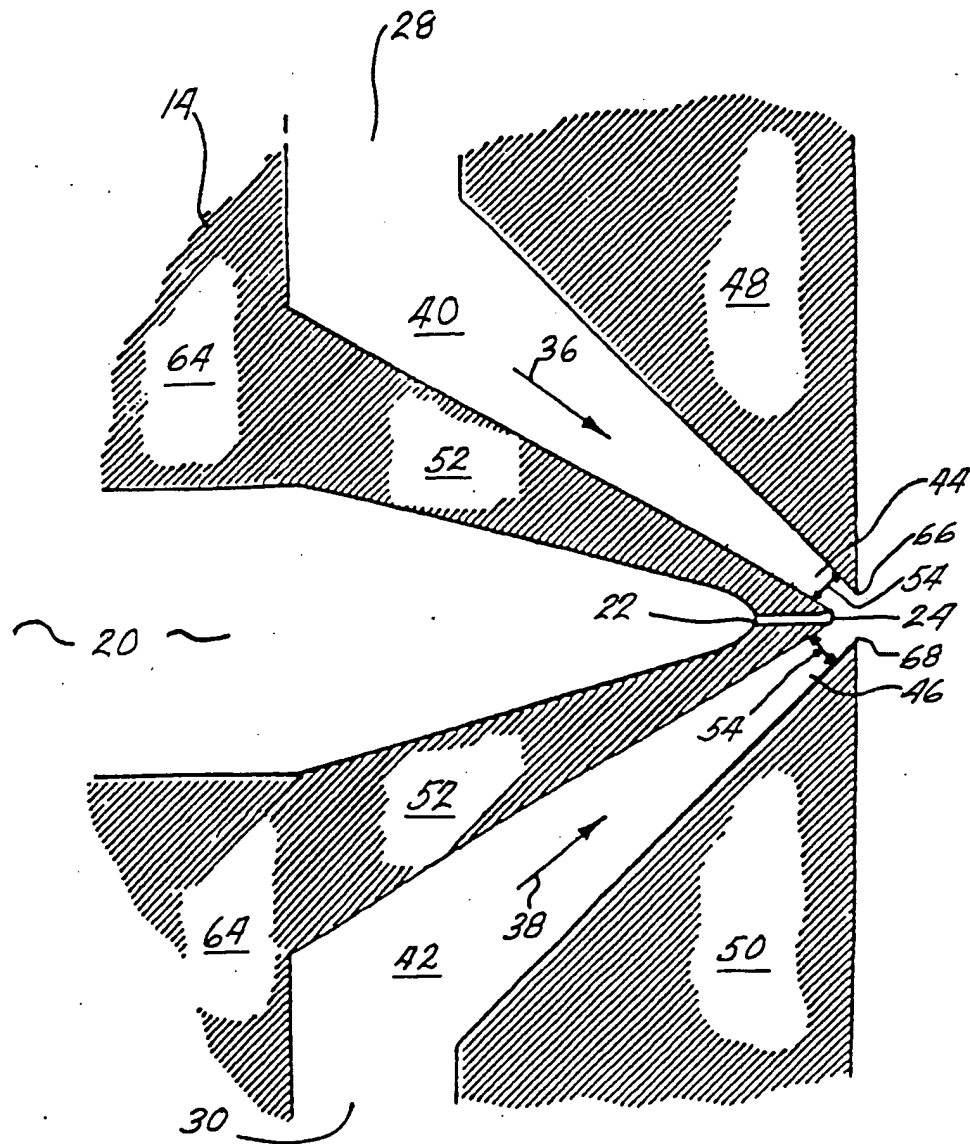


FIG. 3

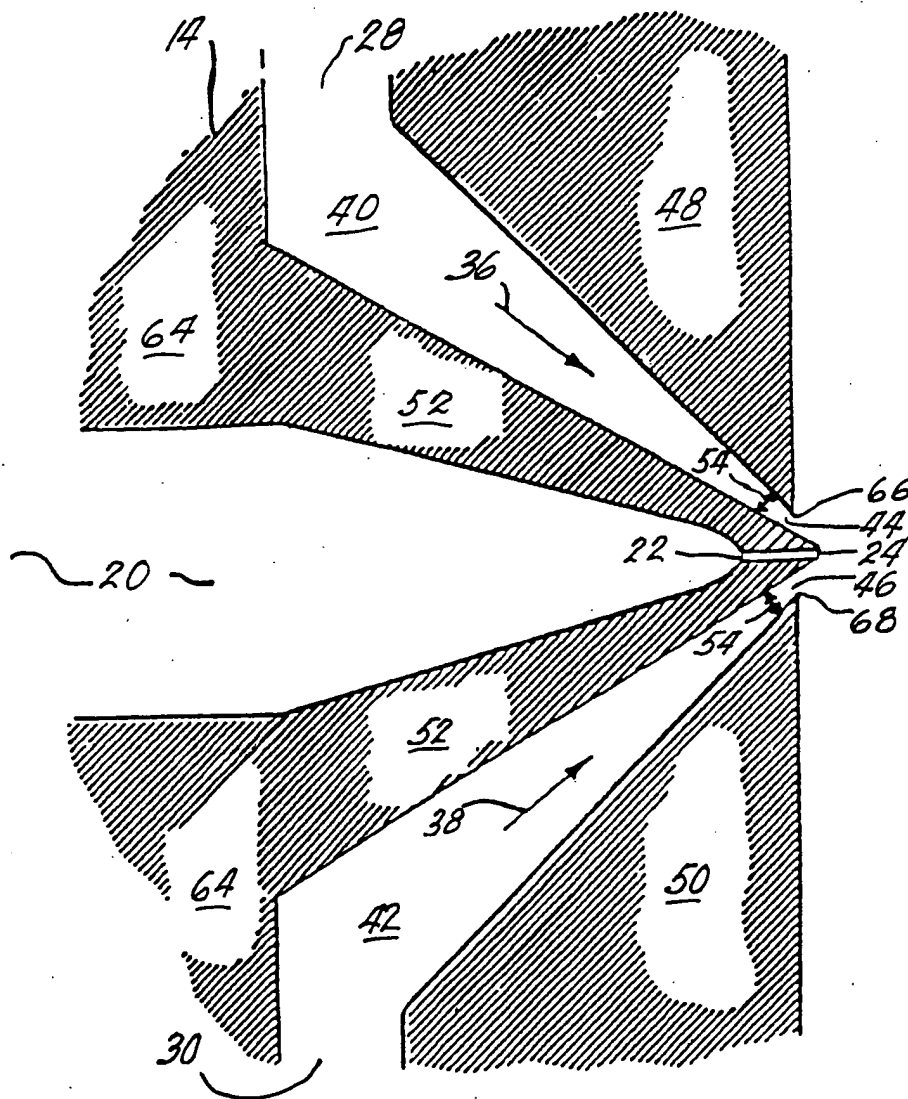


FIG. 4



Fig. 5

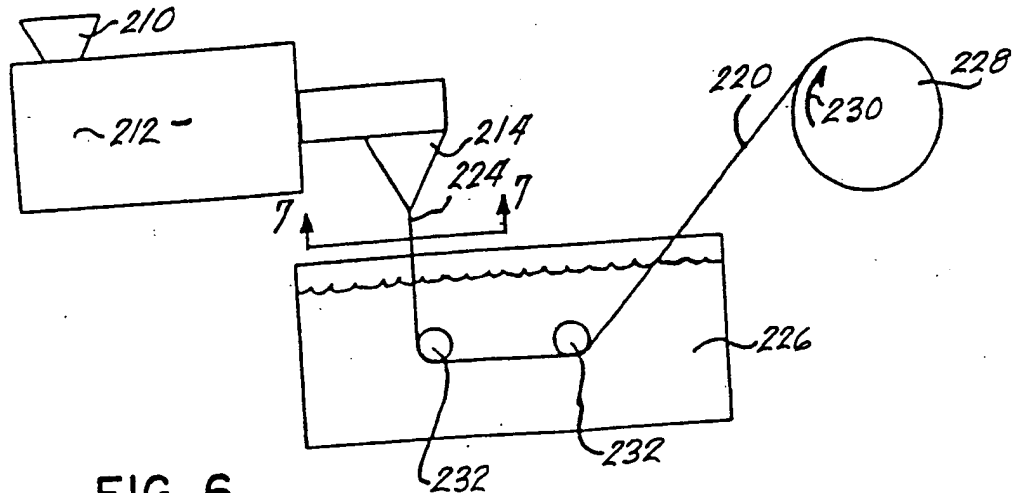


FIG. 6

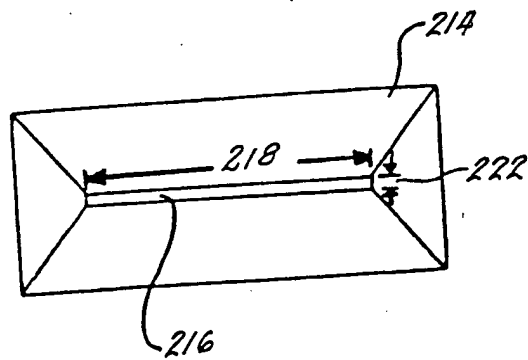


FIG. 7

SPECIFICATION

Polyolefin-containing extrudable compositions and methods for their formation into elastomeric products

The present invention is generally directed to certain extrudable elastomeric compositions and methods for forming the extrudable elastomeric compositions into elastomeric products such as, for example, fibrous nonwoven elastomeric webs.

10 Background of the invention

Meltblowing techniques for forming very small diameter fibers, sometimes referred to as microfibers or meltblown fibers, from thermoplastic resins are well-known in the art. For example, the production of fibers by meltblowing is described in an article entitled "Superfine Thermoplastic Fibers", appearing in *Industrial and Engineering Chemistry*, Vol. 48, No. 8, pp. 1342-1346. This article describes work done at the Naval Research

Laboratories in Washington, D.C. Another publication dealing with meltblowing is *Naval Research Laboratory Report 111437*, dated April 15, 1954. Generally, meltblowing techniques include heating a thermoplastic fiber-forming resin to a molten state and extruding the molten resin from a die arrangement having a plurality of linearly arranged small diameter capillaries as molten threads. The molten threads exit the die into a high velocity stream of gas, usually air, which is maintained at an elevated temperature, and which serves to attenuate the threads of molten resin to form fibers having a diameter which is less than the diameter of the capillaries of the die arrangement.

U.S. patent number 3,459,830 to Legge et al. appears to disclose block copolymer-polyethylene compositions. The patent states that a block copolymer blend is provided which has improved resistance to oxidation, weathering, ozone and solvents by blending a block copolymer such as an A-B-A polystyrene-polybutadiene-

polystyrene block copolymer with a polyethylene having a melt index between about 0.2 and 30.

U.S. patent number 3,459,831 to Luftglass et al. appears to disclose block copolymer-polyethylene films. The patent states that a transparent film is provided by blending a high molecular weight A-B-A block copolymer such as styrene-butadiene-styrene with a polyethylene having a melt index between about 0.2 and 30.

While degradation of some thermoplastic resins prior to their extrusion may be necessary in order to reduce their viscosity sufficiently to allow their extrusion and attenuation by the high velocity stream of attenuating gas, there is a limit to the degree of degradation prior to extrusion which can be imposed on a given resin without adversely affecting the properties of the extruded product. For example, excessive degradation of polymeric elastomeric polystyrene/poly (ethylene-butylene)/polystyrene block copolymer resins, may result in the formation of a non-elastic resin. It is believed that the degraded material is non-elastic because the block

copolymer resin degrades to form a di-block copolymer resin. Other dangers may be associated with high degradation temperatures. For example, Technical Bulletins SC: 38-82 and SC: 39-85 of The Shell Chemical Company of Houston, Texas, in describing polystyrene/poly (ethylene-butylene)/elastomeric block copolymer resins sold by it under the trademark KRATON state that, with respect to the KRATON G 1650 and KRATON G 1652, both of which are block copolymer resins, compounding temperatures of the resin should not be allowed to exceed 525 degrees Fahrenheit, that is 274 degrees Centigrade and that a fire watch should be maintained if the temperature of the resins reaches 475 degrees Fahrenheit, that is 246 degrees Centigrade. With respect to the KRATON GX 1657 block copolymer resin, Shell Technical Bulletin SC: 607-84 gives a warning not to allow the temperature of the block copolymer resin to exceed 450 degrees Fahrenheit, that is 232 degrees Centigrade, and to maintain a fire watch should that temperature be reached. Shell Material Safety Data Sheet designated as

MSDS number 2,136 states, with respect to KRATON G-1657 thermoplastic rubber, that the processing temperature of the material should not be allowed to exceed 550 degrees Fahrenheit (280°C) and that a fire watch should be maintained if that temperature is reached. A Shell Material Safety Data Sheet designated as MSDS 2,031-1 states, with respect to KRATON G-1652 thermoplastic rubber, that the processing temperature of the material should not exceed 550 degrees Fahrenheit (288°C) and that a fire watch should be maintained if that temperature is reached. Shell Chemical Company Technical Bulletins SC: 68-85 "KRATON Thermoplastic Rubber" and SC: 72-85 "Solution Behavior of KRATON Thermoplastic Rubbers" give detailed information concerning various thermoplastic block copolymer resins which may be obtained from Shell under the trade designation KRATON. The KRATON thermoplastic resins are stated by Shell to be A-B-A block copolymers in which the "A" endblocks are polystyrene and the "B" midblock is in KRATON G resins, poly (ethylene-butylene) or, in KRATON D resins, either polyisoprene or polybutadiene.

Shell Chemical Company Technical Bulletin SC: 198-83, at page 19, gives examples of commercially available resins and plasticizers useable with KRATON rubber resins. The Bulletin distinguishes between rubber phase, B midblock, associating materials and polystyrene phase, A endblock, associating materials. Among the rubber phase associating materials is a group of resins which are identified as "Polymerized Mixed Olefin" and a plasticizer identified as "Wingtrack 10" having a chemical base of "mixed olefin".

For quite some time those in the art have been attempting to form elastomeric resins into fibrous nonwoven elastomeric webs. In fact, the prior art reveals that experimentation with KRATON G 1650 and KRATON G 1652 brand materials has occurred. For example, U.S. patent 4,323,534 to des Marais discloses that it was concluded by those in the art that the KRATON G rubber resins are too viscous to be extruded alone without substantial melt fracture of the product. However, des Marais does disclose a process which utilizes blended KRATON G

1650 and KRATON G 1652 resins in the formation of fibrous nonwoven webs and films. In order to overcome the stated viscosity problem the KRATON G 1650 block and KRATON G 1652 copolymer resin was blended with about 20 percent to 50 percent, by weight, of a fatty chemical such as stearic acid prior to extrusion and meltblowing. An extrusion temperature range of 400 to 460 degrees Fahrenheit (204 to 238°C) is disclosed at column 8, line 64 et. seq. and this temperature range is generally within that recommended by the above-mentioned Shell Chemical Company technical bulletins. Unfortunately, the physical properties of the product obtained by this process, for example, a nonwoven mat of meltblown fibers, were apparently unsatisfactory because, after formation of the nonwoven web, substantially all the fatty chemical is leached out of the nonwoven web of extruded microfibers by soaking the web in alcohols having a good ability to solubilize the fatty chemical utilized. In one embodiment, discussed at column 3, lines 8 and 9, the thermoplastic rubber resin is an A-B-A' block copolymer wherein B is poly (ethylene-butylene) and A and A' are selected from the group including polystyrene and poly (alpha-methylstyrene).

U.S. Patent 4,296,163 to Emi appears to disclose a fibrous composite having elasticity. The composite is stated to comprise a sheet-like mesh structure composed of fibers of a synthetic elastomeric polymer and a mat, web or sheet-like fibrous structure composed of short or long fibers. Under the sub-heading "SHEET-LIKE MESH STRUCTURE" polyester elastomers, polyurethane elastomers and polyolefin elastomers are discussed. Examples of polyolefin elastomers are stated to be block copolymers of ethylene and propylene, and copolymers obtained by reacting the block copolymer with diene compounds such as cyclopentadiene, cyclohexadiene, butadiene and isoprene. It is stated that a copolymer of styrene and isoprene can also be used. It is also stated that the elastomeric polymer may contain up to 20% by weight, preferably up to 15% by weight, based on the entire polymer, of another polymer which shows no elasticity, and in some cases, this is preferred. Examples of the other polymer to be mixed with the elastomeric polymer are polyethylene, polypropylene, polystyrene, polyesters, polyamides and polycarbonates.

U.S. Patent 4,305,990 to Kelly appears to disclose that A-B-A block copolymers having a polybutadiene or polyisoprene midblock and polystyrene endblocks may be extruded as films when blended with an amount of amorphous polypropylene sufficient to enhance the processability of the blend. It is stated in the abstract that the films retain their elastomeric properties and are significantly more processable owing to the presence of the amorphous polypropylene.

U.S. Patent 4,413,623 to Pieniak appears to disclose elasticized laminated structures, for example, elasticized diapers, having gathered and ungathered regions with the elastic being placed only in the areas to be gathered. Specific elastomeric materials are disclosed for use and it is stated that the elastomeric components can be linear or radial A¹-B-A² block copolymers or mixtures thereof with simple A-B block copolymers wherein A¹ and A² can be alike or different and represent a thermoplastic polymer block, such as a poly (vinyl arene) block, and B represents an elastomeric polymer block such as a conjugated diene or lower (i.e. C₁-C₄) alkene. A modifier which may be a low molecular weight thermoplastic polymer, for example amorphous polypropylene, having an average molecular weight of about 500 to 7,500 in an amount of from about zero to about 200 parts by weight per 100 parts by weight of the elastomeric component, may be added to improve processability.

Summary of the invention

The present invention overcomes the above-discussed difficulties which have been encountered by those in the art when attempting to form elastomeric A-B-A' block copolymer materials into elastomeric products by providing extrudable elastomeric compositions which, after extrusion, solidify to form elastomeric products such as, for example, fibrous nonwoven elastomeric webs. For example, leaching of materials out of the fibrous nonwoven web or other elastomeric products formed from the extrudable compositions of the present invention is avoided. The extrudable elastomeric compositions are blends of (1) from at least about 10 percent, by weight, of an A-B-A' block copolymer, where "A" and "A'" are each a thermoplastic polymer endblock which includes a styrenic moiety such as a poly (vinyl arene) and where "B" is an elastomeric poly (ethylene-butylene) midblock, with (2) from greater than 0 percent, by weight, to about 90 percent, by weight, of a polyolefin which, when blended with the A-B-A' block copolymer and subjected to appropriate elevated pressure and elevated temperature conditions, is extrudable, in blended form, with the A-B-A' block copolymer. The A-B-A' block copolymer serves to impart elastomeric properties to products formed from the extrudable composition and the presence of the polyolefin in the blend serves to reduce the viscosity of the composition as compared to the viscosity of the neat, i.e. pure, A-B-A' block copolymer and thus enhances the extrudability of the composition.

According to one feature of the present invention, there is thus provided an extrudable elastomeric composition comprising:

at least about 10 percent, by weight, of an A-B-A' block copolymer where "A" and "A'" are each a thermoplastic endblock which comprises a styrenic moiety and where "B" is an elastomeric poly (ethylene-butylene) midblock, and

from greater than 0 percent, by weight, up to about 90 percent, by weight, of at least one polyolefin which, when blended with the A-B-A' block copolymer and subjected to an effective combination of elevated temperature and elevated pressure conditions, is adapted to be extruded, in blended form, with the A-B-A' block copolymer.

According to further features of the invention we provide:

(a) a fibrous non-woven elastomeric web including microfibers, said microfibers having been formed from an extrudable composition according to the invention as herein defined;

- b) a process for forming such a cohesive fibrous nonwoven elastomeric web from an extrudable composition according to the invention which includes the steps of:
 subjecting the extrudable composition to a combination of elevated temperature and elevated pressure conditions to effect extrusion of the extrudable composition from a meltblowing die as molten threads;
 5 applying a heated, pressurized stream of an attenuating gas to the molten threads to attenuate the molten threads to microfibers; and
 collecting the microfibers as a cohesive fibrous nonwoven elastomeric web;
 c) a coformed fibrous nonwoven elastomeric web including:
 at least about 20 percent, by weight, of a fibrous nonwoven elastomeric web according to feature (a) of the
 10 invention as hereinbefore defined; and
 from greater than 0 percent, by weight, to about 80 percent, by weight, of at least one secondary fiber generally uniformly distributed throughout the fibrous nonwoven elastomeric web;
 d) a process for forming an elastomeric material from an extrudable composition according to the invention as hereinbefore defined, said process including the steps of:
 15 subjecting the extrudable composition to a combination of elevated temperature and elevated pressure conditions to form the extrudable composition into said elastomeric material;
 e) an elastomeric film extruded from an extrudable composition as herein defined; and
 f) a process for forming such a film which includes the steps of:
 subjecting the extrudable composition to a combination of elevated temperature and elevated pressure
 20 conditions sufficient to effect extrusion of the extrudable composition from a film die as a molten film;
 drawing the molten film to reduce the thickness of the molten film; and
 cooling the molten film by quenching.
- Preferably, the A and A' thermoplastic styrenic moiety containing endblocks of the block copolymer are selected from the group including polystyrene and polystyrene homologs such as, for example, poly
 25 (alpha-methylstyrene). In some embodiments the A and A' thermoplastic styrenic moiety containing endblocks are identical. Preferably, the polyolefin is selected from the group including at least one polymer selected from the group including polyethylene, polypropylene, polybutene, ethylene copolymers, propylene copolymers, butene copolymers or blends of two or more of these materials.
- The blend usually includes from at least about 20 percent, by weight, to about 95 percent, by weight, of the
 30 block copolymer and from at least about 5 percent, by weight, to about 80 percent, by weight, of the polyolefin. For example, the blend may include from about 30 percent, by weight, to about 90 percent, by weight, of the block copolymer and from about 10 percent, by weight, to about 70 percent, by weight, of the polyolefin. Preferably, the blend includes from about 50 percent, by weight, to about 90 percent, by weight, of the block copolymer and from about 10 percent, by weight, to about 50 percent, by weight, of the polyolefin. For example,
 35 the blend may include from about 50 percent, by weight, to about 70 percent, by weight, of the block copolymer and from about 30 percent, by weight, to about 50 percent, by weight, of the polyolefin. One blend includes about 60 percent, by weight, of the block copolymer and about 40 percent, by weight, of the polyolefin.
- The extrudable composition is extruded or otherwise formed such as, for example, by molding, for example, injection molding, at an appropriate, that is effective, combination of elevated pressure and elevated temperature
 40 conditions. These conditions will vary depending on the polyolefin utilized. For example, the extrudable composition should be extruded or otherwise formed at a temperature of at least about 125 degrees Centigrade if polyethylene is utilized as the polyolefin in the blend or at least about 175 degrees Centigrade if polypropylene is utilized in the blend, for example, at a temperature of from at least about 290 degrees Centigrade to about 345
 45 degrees Centigrade, more specifically, at a temperature of from at least about 300 degrees Centigrade to about 335 degrees Centigrade, into elastomeric products such as, for example, elastomeric fibers, which may be collected as a fibrous nonwoven elastomeric web.
- Preferably the blends are extrudable within the above-defined temperature ranges at elevated pressures within the die tip, (for example, within the extrusion capillaries of a die tip having thirty (30) extrusion capillaries per
 50 lineal inch of die tip (12 capillaries per centimetre with each of the capillaries having a diameter of 0.0145 inches (0.37mm) and a length of 0.113 inches (2.87mm).) of no more than about 300 pounds per square inch, gage, ($2 \times 10^5 \text{ Pa}$) for example, from pressures of from about 20 pounds per square inch ($1.4 \times 10^5 \text{ Pa}$), gage to about 250 pounds per square inch ($1.7 \times 10^5 \text{ Pa}$) gage. More specifically, the blends are extrudable within the above-defined temperature ranges at pressures of from about 50 pounds per square inch, ($3.4 \times 10^5 \text{ Pa}$, gage to about 250 pounds per square inch ($1.7 \times 10^5 \text{ Pa}$), gage, for example, from about 125 pounds per square inch
 55 ($8.6 \times 10^5 \text{ Pa}$), gage to about 225 pounds per square inch ($1.5 \times 10^6 \text{ Pa}$) gage. Higher elevated pressures can be utilized with other die designs having a lower number of capillaries per inch of die, but, generally speaking, lower production rates result.
- Importantly, it has been found that the extrudable compositions of the present invention, when treated in accordance with the method of the present invention, are extrudable at satisfactory throughput rates because the
 60 presence of the polyolefin in the extrudable composition reduces the viscosity of the extrudable composition, as compared to the viscosity of the neat, i.e. pure, block copolymer, to satisfactory levels. This reduced viscosity proportionally reduces the die tip pressure if all other parameters remain the same. For example, the viscosity of the extrudable compositions will generally be less than about 500 poise when extruded at the above-defined elevated temperature and elevated pressure ranges. Preferably, the viscosity of the extrudable composition is less
 65 than about 300 poise when extruded at the above-defined elevated temperature and elevated pressure ranges.

For example, the viscosity of the extrudable composition may be from at least about 100 poise to about 200 poise when extruded at the above-identified elevated temperature and elevated pressure conditions.

Because the polyolefin reduces the viscosity of the blend, as compared to the viscosity of the block copolymer, the extrudable composition is extrudable within the above-identified elevated temperature and elevated pressure ranges, through a die tip having, for example, thirty capillaries per inch of die tip (12 capillaries per centimetre) with the capillaries having a diameter of about 0.0145 inches (0.37mm) and a length of about 0.113 inches (2.87mm) at a rate of from at least about 0.02 grams per capillary per minute to about 1.7 or more grams per capillary per minute. For example, the extrudable composition may be extruded through the above-identified die tip having capillaries with a diameter of about 0.0145 inches (0.37mm) and a length of about 0.113 inches (2.87mm) at the rate of from at least about 0.1 grams per capillary per minute to about 1.25 grams per capillary per minute. Preferably, the extrudable composition is extrudable through the above-identified die tip having capillaries with a diameter of about 0.0145 inches (0.37mm) and a length of about 0.113 inches (2.87mm) at the rate of from at least about 0.3 grams per capillary per minute to about 1.1 grams per capillary per minute.

The extrudable composition may be formed into a variety of products such as, for example, fibrous nonwoven elastomeric webs preferably having microfibers with an average diameter of not greater than about 100 microns, and preferably having an average basis weight of not more than about 300 grams per square meter, for example, an average basis weight of from about 5 grams per square meter to about 100 grams or more per square meter. More specifically, the web may have an average basis weight of from about 10 grams per square meter to about 75 grams per square meter. For example, a fibrous nonwoven elastomeric web may be formed by extruding the extrudable composition at an appropriate, i.e. effective, combination of elevated temperature and elevated pressure conditions. Preferably, the extrudable composition is extruded at a temperature of from at least about 125 degrees Centigrade if the polyolefin is a polyethylene or at least about 175 degrees Centigrade if the polyolefin is polypropylene, for example, from about 290 degrees Centigrade to about 345 degrees Centigrade, more specifically from about 300 degrees Centigrade to about 335 degrees Centigrade. Preferably, the extrudable composition is extruded within the above-identified temperature ranges at pressures, within the die tip, (for example, within the extrusion capillaries of a die tip having thirty (30) extrusion capillaries per lineal inch of die tip (12 per centimetre) with each of the capillaries having a diameter of 0.0145 inches (0.37mm) and a length of 0.113 inches (2.87mm)) of no more than about 300 pounds per square inch (2MPa) gage, for example, from about 20 pounds per square inch, gage to about 250 pounds per square inch, gage (0.14 to 1.7MPa). More specifically, the extrudable composition is extruded at a pressure within the capillaries of the above-identified die tip of from about 50 pounds per square inch, gage to about 250 pounds per square inch, gage, (0.34 to 1.7MPa) for example, from about 125 pounds per square inch, gage to about 225 pounds per square inch, gage (0.86 to 1.5MPa).

In the formation of elastomeric nonwoven webs, the extrudable composition is extruded, at the above-defined elevated temperature and elevated pressure conditions at a rate of from at least about 0.02 gram per capillary per minute to about 1.7 or more grams per capillary per minute, for example, from at least about 0.1 gram per capillary per minute to about 1.25 grams per capillary per minute, more specifically, from at least about 0.3 gram per capillary per minute to about 1.1 grams per capillary per minute, through a die having a plurality of small diameter extrusion capillaries as molten threads into a gas stream which attenuates the molten threads to provide a gas-borne stream of microfibers which are then formed into the fibrous nonwoven elastomeric web upon their deposition on a collecting arrangement. The attenuating gas stream is applied to the molten threads at a temperature of from at least 100 degrees Centigrade to about 400 degrees Centigrade, for example, from about 200 degrees Centigrade to about 350 degrees Centigrade and at a pressure of from at least about 0.5 pound per square inch (3400 Pa) gage to about 20 pounds per square inch (1.4×10^5 Pa) gage, for example, from at least about 1 pound per square inch (6900 Pa) gage to about 10 pounds per square inch (6.9×10^4 Pa) gage. The thread attenuating gas stream may be an inert, non-oxidizing, gas stream such as, for example, a stream of nitrogen gas. In some embodiments the velocity and temperature of the thread-attenuating gas stream is adjusted so that the fibers are collected as substantially continuous fibers having diameters of from about ten (10) microns to about sixty (60) microns, for example, from at least about ten (10) microns to about forty (40) microns. In accordance with the present invention, the fibrous nonwoven elastomeric webs so formed will include elastomeric fibers composed of from at least about 10 percent, by weight, of the block copolymer and greater than 0 percent, by weight, and up to about 90 percent, by weight, of the polyolefin. The fibers are usually composed of from at least about 20 percent, by weight, to about 95 percent, by weight, of the block copolymer and from at least about 5 percent, by weight, to about 80 percent, by weight, of the polyolefin. For example, the fibers may be composed of from at least about 30 percent, by weight, to about 90 percent, by weight, of the block copolymer and from at least about 10 percent, by weight, to about 70 percent, by weight, of the polyolefin. Preferably, the fibers are composed of from about 50 percent, by weight, to about 90 percent, by weight, of the block copolymer and from at least about 10 percent, by weight, to about 50 percent, by weight, of the polyolefin. For example, the fibers may be composed of from at least about 50 percent, by weight, to about 70 percent, by weight, of the block copolymer and from at least about 30 percent, by weight, to about 50 percent, by weight, of the polyolefin. Exemplary fibrous nonwoven elastomeric webs have been formed from fibers composed of about 60 percent, by weight, of the block copolymer and about 40 percent, by weight, of the polyolefin.

The present invention is also directed to the formation of an elastomeric film from the blend of materials described above.

Still other aspects of the present invention will become apparent to those skilled in the art upon review of the following detailed disclosure.

Definitions

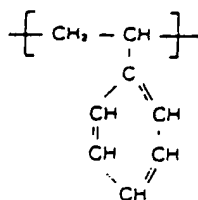
The terms "elastic" and "elastomeric" are used interchangeably herein to mean any material which, upon application of a biasing force, is stretchable to a stretched, biased length which is at least about 125 percent, that is about one and one quarter, of its relaxed, unbiased length, and which, will recover at least 40 percent of its elongation upon release of the stretching, elongating force. A hypothetical example which would satisfy this definition of an elastomeric material would be a one (1) centimetre sample of a material which is elongatable to at least 1.25 cm and which, upon being elongated to 1.25 cm and released, will recover to a length of not more than 1.15 cm. Many elastic materials may be stretched by much more than 25 percent of their relaxed length and many of these will recover to substantially their original relaxed length upon release of the stretching, elongating force and this latter class of materials is generally preferred for purposes of the present invention.

As used herein the term "recover" refers to a contraction of a stretched material upon termination of a biasing force following stretching of the material by application of the biasing force. For example, if a material having a relaxed, unbiased length of one (1) centimetre was elongated 50 percent by stretching to a length of one and one half (1.5) centimetres the material would have been elongated 50 percent and would have a stretched length that is 150 percent of its relaxed length. If this exemplary stretched material contracted, that is recovered to a length of one and one tenth (1.1) centimetres after release of the biasing and stretching force, the material would have recovered 80 percent (0.4 cm) of its elongation.

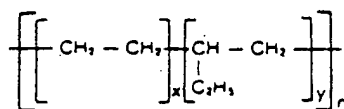
The term "microfibers" is used herein to refer to small diameter fibers having an average diameter not greater than about 100 microns, preferably having a diameter of from about 0.5 microns to about 50 microns, more preferably having an average diameter of from about 4 microns to about 40 microns and which may be made by extruding a molten thermoplastic material through a plurality of small diameter, usually circular, die capillaries as molten threads and attenuating the molten threads by application of a high velocity gas, usually air, stream to reduce their diameter to the range stated above.

As used herein the term "nonwoven web" means a web of material which has been formed without use of weaving processes which produce a structure of individual fibers or threads which are interwoven in an identifiable repeating manner. Nonwoven webs have been, in the past, formed by a variety of processes such as, for example, meltblowing processes, spunbonding processes, film aperturing processes and staple fiber carding processes.

As used herein the term "styrenic moiety" refers to the monomeric unit represented by the formula:

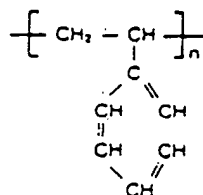


As used herein the term "poly (ethylene-butylene)" refers to a polymer segment represented by the formula:



where x, y and n are positive integers.

As used herein the term "polystyrene" refers to a polymer segment represented by the formula:



where n is a positive integer.

Unless specifically set forth and defined or otherwise limited, the terms "polymer" or "polymer resin" as used herein generally include, but are not limited to, homopolymers, copolymers, such as, for example, block, graft, random and alternating copolymers, terpolymers, etc. and blends and modifications thereof. Furthermore, unless otherwise specifically limited, the terms "polymer" or "polymer resin" shall include all possible geometrical configurations of the material. These configurations include, but are not limited to, isotactic, syndiotactic and random symmetries.

As used herein the term "viscosity" refers to a value which has been calculated by utilizing the well-known Hagen-Poiseuille equation:

$$\text{viscosity} = \frac{(\pi) (\Delta P) (R^4) D}{8QL}$$

where

- 5 π = 3.14....
 ΔP = the pressure drop through an extrusion capillary.
 R = the radius of the extrusion capillary.
 Q = the volume rate of extrusion (through-put) through the extrusion capillary.
 L = the length of the extrusion capillary.
 10 D = the density of the molten polymer, assumed in all cases herein to be 0.8 grams per cubic
 centimeter.

As used herein an "inert" attenuating gas is a non-oxidizing gas which does not degrade the material being meltblown.

15 *Brief description of the drawings*

Figure 1 is a perspective schematic view illustrating one embodiment of a process for forming a nonwoven elastomeric web in accordance with the present invention.

Figure 2 is a perspective view of the meltblowing die illustrated in *Figure 1* which illustrates the linear arrangement of the capillaries of the die.

20 *Figure 3* is a schematic cross-sectional view of the die illustrated in *Figure 1*, along line 2-2 of *Figure 2*, illustrating the die in a recessed die tip arrangement.

Figure 4 is a schematic cross-sectional view of the die illustrated in *Figure 1*, along line 2-2 of *Figure 2*, illustrating the die in a positive die tip stick-out arrangement.

25 *Figure 5* is a schematic cross-sectional view with portions broken away for purposes of illustration of an arrangement which may be utilized to incorporate discrete particles, fibers or other materials into the extruded threads of molten material prior to their formation into a nonwoven web.

Figure 6 is a schematic representation illustrating apparatus for forming elastomeric films in accordance with the present invention.

30 *Figure 7* is a plan view of the die arrangement illustrated in *Figure 6* as viewed from the line 7-7 in *Figure 6*.

Description of the preferred embodiments

The methods and extrudable compositions of the present invention have broad application in the formation of elastomeric materials such as elastomeric fibers which may be formed into elastomeric webs or other products, by suitable methods such as, for example, extrusion or molding processes. A particularly preferred method, however, is to meltblow fibers to form a fibrous nonwoven elastomeric web.

Meltblowing processes generally involve extruding a thermoplastic polymer resin through a plurality of small diameter capillaries of a meltblowing die as molten threads into a heated gas stream which is flowing generally in the same direction as that of the extruded threads so that the extruded threads are attenuated, i.e., drawn or extended, to reduce their diameter to fiber or preferably microfiber size. The thus formed microfibers are then borne away from the vicinity of the die by the gas stream. The gas stream is directed onto a foraminous member, such as a screen belt or a screen drum which is moving over a vacuum box, so that the gas-borne fibers impinge upon and are collected on the surface of the foraminous member and form a cohesive fibrous non-woven web.

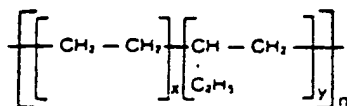
Meltblowing die arrangements usually extend across the foraminous collecting members in a direction which is substantially transverse to the direction of movement of the collecting surface. The die arrangements include a plurality of small diameter capillaries arranged linearly along the transverse extent of the die with the transverse extent of the die being approximately as long as the desired width of the fibrous nonwoven web which is to be produced. That is, the transverse dimension of the die is the dimension which is defined by the linear array of die capillaries. Typically, the diameter of the capillaries will be on the order of from about 0.01 inches to about 0.02 inches, (0.25-0.5mm) for example, from about 0.0145 to about 0.018 inches. (0.37-0.46mm) From about 5 to about 50 such capillaries will be provided per linear inch of die face. (2-20 per cm) Typically, the length of the capillaries will be from about 0.05 inches to about 0.20 inches, (1.3-5.1 mm) for example, about 0.113 inches to about 0.14 inches long. (2.9-3.6 mm) A meltblowing die can extend for from about 30 inches to about 60 or more inches in length in the transverse direction. (76-152 cm) As a result of the above-discussed linear capillary configuration meltblowing dies, in the vicinity of the capillaries, are usually held together only by a thin and relatively fragile portion of metal which remains between the adjacent capillaries. Consequently, controlling the viscosity of the molten thermoplastic polymer resin as it is extruded through the capillaries is important because the die will rupture or otherwise break if subjected to extreme pressure. It is therefore generally preferred, at least for many such dies, that the extrusion pressure of the molten thermoplastic polymer in the die tip capillaries not exceed more than about 300 pounds per square inch, gage (2×10^6 Pa), more specifically not more than about 200 psi, g. (1.4×10^6 Pa)

As has been stated by those in the art in the above-discussed patents to des Marais and Jones, the viscosity of KRATON G brand A-B-A' block copolymers is so great that extrusion of these materials, in pure or neat form, within the typical extrusion temperature and pressure ranges stated therein is, for all practical purposes, very difficult, if not impossible, without melt fracture of the composition. In attempting to overcome the difficulties of

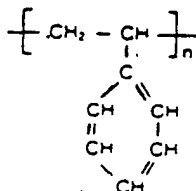
extruding neat KRATON G brand materials des Marais and Jones appear to have discovered that the use of a blend of a fatty chemical with elastomeric A-B-A' rubber resins, of the type sold under the trademark KRATON G by the Shell Chemical Company, facilitated extrusion of the KRATON G materials. However, they also state that, in order to achieve desirable properties in the film or the web of meltblown fibers obtained from this blend, it was necessary to leach out the fatty chemical from the extruded product.

In contrast to such teachings, it has now been found that a blend of from greater than 0 percent, by weight, to about 90 percent, by weight, of one or more polyolefins with from at least about 10 percent, by weight, of certain A-B-A' elastomeric resins can be extruded and meltblown under appropriate, i.e. effective, elevated temperature and elevated pressure conditions to provide satisfactory elastomeric materials such as elastomeric films and elastomeric fibrous nonwoven webs. Preferably the material is extruded through the die capillaries at a temperature of at least about 125 degrees Centigrade if polyethylene is utilized as the polyolefin in the blend or at least about 175 degrees Centigrade if a polypropylene is utilized as the polyolefin in the blend, for example at a temperature of from at least about 290 degrees Centigrade to about 345 degrees Centigrade, more specifically from a temperature of from at least about 300 degrees Centigrade to about 335 degrees Centigrade.

The A-B-A' elastomeric materials which may be utilized generally include A-B-A' block copolymers where A and A' are each a thermoplastic polymer endblock which contains a styrenic moiety such as, for example, a poly(vinyl arene) where, in some embodiments, A may be the same thermoplastic polymer endblock as A', and where B is an elastomeric poly(ethylene-butylene) polymer midblock. Preferably, the A and A' endblocks are selected from the group of materials including polystyrene or polystyrene homologs such as, for example, poly(alpha-methylstyrene). Materials of this general type, that is KRATON G 1650 and KRATON G 1652, are disclosed in U.S. patents 4,323,534 to des Marais and 4,355,425 to Jones and in the aforementioned Shell brochures which also discloses KRATON GX 1657. Commercially available elastomeric A-B-A' block copolymers having a saturated or essentially saturated poly(ethylene-butylene) midblock "B" represented by the formula:



where x, y and n are positive integers and polystyrene endblocks "A" and "A'" each represented by the formula:



where n is a positive integer which may be of the same or a different integer for the A and A' endblocks, are sometimes referred to as S-EB-S block copolymers and are available under the trade designation KRATON G, for example, KRATON G 1650, KRATON G 1652 and KRATON GX 1657, from the Shell Chemical Company.

A summary of the typical properties, as published by the Shell Chemical Company, of the above-identified KRATON G resins at 74 degrees Fahrenheit (23°C) is presented below in Table I.

TABLE I

KRATON G

Property	G-1650	G-1652	GX-1657
Tensile Strength, psi ¹ (Pa)	5,000 ² (3.4 × 10 ⁷)	4,500 ² (3.1 × 10 ⁷)	3,400 ² (2.3 × 10 ⁷)
300% Modulus, psi ¹ (Pa)	800 (5.5 × 10 ⁶)	700 (4.8 × 10 ⁶)	350 (2.4 × 10 ⁶)
Elongation, % ¹	500	500	750
Set at Break, %	—	—	—
Hardness, Shore A	75	75	65
Specific Gravity	0.91	0.91	0.90
Brookfield Viscosity, (Toluene Solution) cps at 77 °F (25°C)	1,500 ³	550 ³	1,200 ³
Melt Viscosity, Melt Index, Condition G, gms/10 min.	—	—	—
Plasticizer Oil Content, %w	0	0	0
Styrene/Rubber ⁴ Ratio	28/72	29/71	14/86
Physical Form	Crumb	Crumb	Pellet

¹ ASTM method D412-tensile test jaw separation speed 10 in./min. (25cm/min)

² Typical properties determined on film cast from a toluene solution.

³ Neat polymer concentration, 20%w.

⁴ The ratio of the sum of the molecular weights of the endblocks (A + A') to the molecular weight of the B midblock. For example, with respect to KRATON G-1650, the sum of the molecular weights of the two endblocks (A + A') is 28 percent of the molecular weight of the A-B-A' block copolymer.

Generally, the block resin must be one which is free of polymer segments which chain scission or which crosslink at the temperatures utilized by the process of the present invention because such materials will either tend to plug up the small diameter capillaries through which the molten extrudable composition must be extruded or will overly degrade and form unsatisfactory product. Surprisingly, it has been found that, even at high polyolefin contents, fibrous nonwoven webs having elastomeric properties can be formed without the necessity of a post formation treatment such as, for example, leaching to remove the additives from the finished product.

The polyolefin which is utilized in blending the extrudable composition must be one which, when blended with the A-B-A' block copolymer and subjected to an appropriate combination of elevated pressure and elevated temperature conditions, as defined herein, is extrudable, in blended form, with the A-B-A' block copolymer. In particular, preferred polyolefin materials include polyethylene, polypropylene and polybutene, including ethylene copolymers, propylene copolymers and butene copolymers. Blends of two or more of the polyolefins may be utilized. A particularly preferred polyethylene may be obtained from U.S.I. Chemical Company under the trade designation Petrothene Na601. (Also referred to herein as PE Na601.) A particularly preferred polypropylene may be obtained from The Himont Corporation under the trade designation PC-973.

Information obtained from U.S.I. Chemical Company states that the Na601 is a low molecular weight, low density polyethylene for application in the areas of hot melt adhesives and coatings. U.S.I. has also stated that the Na601 has the following nominal values: (1) a Brookfield Viscosity, cP at 150 degrees Centigrade of 8500 and at 190 degrees Centigrade of 3300 when measured in accordance with ASTM D 3236; (2) a density of 0.903 grams per cubic centimeter when measured in accordance with ASTM D 1505; an equivalent Melt index of 2000 grams per ten minutes when measured in accordance with ASTM D 1238; (4) a ring and ball softening point of 102 degrees Centigrade when measured in accordance with ASTM E 28; (5) a tensile of 850 pounds per square inch (5.9×10^6 Pa) when measured in accordance with ASTM D 638; (6) an elongation of 90 percent when measured in accordance with ASTM D 638; (7) a modulus of Rigidity, T_r (45,000) of -34 degrees Centigrade and (8) a penetration Hardness, (tenths of mm) at 77 degrees Fahrenheit (25°C) of 3.6.

The Na601 is believed to have a number average molecular weight (M_n) of about 4,600; a weight average molecular weight (M_w) of about 22,400 and a Z average molecular weight (M_z) of about 83,300. The polydispersity (M_w/M_n) of the Na601 is about 4.87.

M_n is calculated by the formula:

$$M_n = \frac{\sum [(n) (MW)]}{\sum (n)}$$

M_w is calculated by the formula:

$$M_w = \frac{\sum [(n) (MW)^2]}{\sum [(n) (MW)]}$$

M_z is calculated by the formula:

$$M_z = \frac{\sum [(n) (MW)^3]}{\sum [(n) (MW)^2]}$$

where:

MW = The various molecular weights of the individual molecules in a sample, and

n = The number of molecules in the given sample which have a given molecular weight of MW.

Typical characteristics of the Himont PC-973 polypropylene as stated by Himont are a density of about 0.900 grams per cubic centimeter measured in accordance with ASTM D 792. A meltflow rate obtained in accordance with ASTM D 1238, Condition L, of about 35 grams per ten (10) minutes. Other characteristics of the PC-973 are a tensile of about 4,300 pounds per square inch (3×10^7 Pa) measured in accordance with ASTM D638; a flex modulus of about 182,000 psi (1.3×10^9 Pa) measured in accordance with ASTM D 790,B and a Rockwell hardness, R scale, of about 93 measured in accordance with ASTM D 785A. The PC-973 is believed to have a number average molecular weight (M_n) of about 40,100; a weight average molecular weight (M_w) of about 172,000 and a Z average weight (M_z) of about 674,000. The polydispersity of the PC-973 (M_w/M_n) is about 4.29.

The blend usually includes from at least about 20 percent, by weight, to about 95 percent, by weight, of the block c polymer and from at least about 5 percent, by weight, to about 80 percent, by weight, of the polyolefin. For example, the blend may include from at least about 30 percent, by weight, to about 90 percent, by weight, of the block copolymer and from at least about 10 percent, by weight, to about 70 percent, by weight, of the polyolefin. Preferably, the blend includes from at least about 50 percent, by weight, to about 90 percent, by weight, of the block copolymer and from at least about 10 percent, by weight, to about 50 percent, by weight, of the polyolefin. For example, the blend may include from about 50 percent, by weight, to about 70 percent, by weight, of the block copolymer and from about 30 percent, by weight, to about 50 percent, by weight, of the polyolefin. One preferred blend includes about 60 percent, by weight, of the block copolymer and about 40 percent, by weight, of the polyolefin.

The preferred elevated temperatures of extrusion and the presence of the specified polyolefin in the blend reduces the viscosity of the blend, as compared to the viscosity of the pure, i.e. neat, A-B-A' block copolymer, and thus forms an extrudable composition which can be utilized in the meltblowing of fibers and microfibers. However, both the block copolymer resins and the polyolefins must be able to sustain the extrusion temperatures utilized by the method of the present invention without undergoing excessive chain scission or excessive thermal or oxidative degradation. In this regard it is believed that the degree of oxidative degradation sustained by the extrudable composition may be reduced by using an inert gas as the attenuating gas stream in the meltblowing step. It is also believed that the degree of oxidative degradation can be reduced by blanketing the raw pellets of the resins utilized with an inert gas prior to their processing by an extruder. The fact that the amount of oxidative degradation which the block copolymer undergoes during extrusion may be reduced by using an inert gas as the attenuating gas stream is generally implied by thermogravimetric analyses of KRATON GX 1657 block copolymer resin which were carried out in air and nitrogen. In these analyses samples of the KRATON GX 1657 block copolymer resin, when heated in air, showed a weight loss beginning at about 307 degrees Centigrade whereas a comparison sample heated in nitrogen showed only a weight loss starting at about 375 degrees Centigrade. It is believed that these results indicate that the effects of oxidative degradation on the sample heated in air could be avoided or diminished by use of an inert or, at least, a non-oxidizing attenuating gas stream to thus limit degradation of the extrudable composition during attenuation at high attenuating gas temperatures and/or by use of an inert or, at least, non-oxidizing gas to blanket the raw pellets.

Referring now to the drawings where like reference numerals represent like structure or like process steps and, in particular, to Figure 1 which schematically illustrates apparatus for forming an elastomeric nonwoven web in accordance with the present invention, it can be seen that a blend (not shown) of (a) from at least about 10 percent, by weight, of an A-B-A' block copolymer where A and A' are both thermoplastic polymer endblocks containing a styrenic moiety such as, for example, a poly (vinyl arene) and where B is an elastomeric poly (ethylene-butylene) midblock, with (b) from greater than 0 percent, by weight, to about 90 percent, by weight, of a polyolefin which, when blended with the A-B-A' block copolymer and subjected to an effective combination of elevated temperature and elevated pressure conditions, is extrudable in blended form with the A-B-A' block copolymer, is supplied in, for example, pellet form to a hopper 10 of an extruder 12. The components of the blend may be supplied in pellet or other form. The components (i.e., pellets) may be blanketed with an inert or, at least, non-oxidative gas while in the hopper 10. This is believed to reduce the effects of oxidative degradation on the blend by both reducing the contact of the blend with normal atmosphere while in the hopper 10 and also increasing the likelihood that any gas that is drawn into and through the extruder 12 will be the inert gas as opposed to oxygen-containing normal atmosphere. The blend usually includes from at least about 20 percent, by weight, to about 95 percent, by weight, of the block copolymer and from about 5 percent, by weight, to about 80 percent, by weight, of the polyolefin. For example, the blend may include from about 30 percent, by weight, to about 90 percent, by weight, of the block copolymer and from about 10 percent, by weight, to about 70 percent, by weight, of the polyolefin. Preferably, the blend includes from about 50 percent, by weight, to about 90 percent, by weight, of the block copolymer and from about 10 percent, by weight, to about 50 percent, by weight, of the polyolefin. For example, the blend may include from about 50 percent, by weight, to about 70 percent, by weight, of the block copolymer and from about 30 percent, by weight, to about 50 percent, by weight, of the polyolefin. Several of the hereinafter discussed examples include about 60 percent, by weight, of the block copolymer and about 40 percent, by weight, of the polyolefin.

The temperature of the blend is elevated within the extruder 12 by a conventional heating arrangement (not shown) to melt the blend and pressure is applied to the blend by the pressure-applying action of a turning screw (not shown), located within the extruder, to form the blend into an extrudable composition. Preferably the blend is heated to a temperature of at least about 125 degrees Centigrade if polyethylene is utilized as the polyolefin in the blend or at least about 175 degrees Centigrade if polypropylene is utilized as the polyolefin in the blend, for example, at a temperature of from at least about 290 degrees Centigrade to about 345 degrees Centigrade, more specifically, at a temperature of from at least about 300 degrees Centigrade to about 335 degrees Centigrade. The extrudable composition is then forwarded by the pressure applying action of the turning screw to a meltblowing die 14. The elevated temperature of the extrudable composition is maintained in the meltblowing die 14 by a conventional heating arrangement (not shown). The die 14 generally extends a distance which is about equal to the width 16 of the nonwoven web 18 which is to be formed by the process. The combination of elevated temperature and elevated pressure conditions which effect extrusion of the composition will vary over wide ranges. For example, at higher elevated temperatures, lower elevated pressures will result in satisfactory extrusion rates and, at higher elevated pressures of extrusion, lower elevated temperatures will effect satisfactory

extrusion rates.

Figures 3 and 4 best illustrate that the meltblowing die 14 includes an extrusion slot 20 which receives the extrudable composition from the extruder 12. The extrudable composition then passes through the extrusion slot 20 and through a plurality of small diameter capillaries 22, which exit the die 14 in a linear arrangement, best illustrated in Figure 2, extending across the tip 24 of the die 14, to emerge from the capillaries 22 as molten threads 26. Preferably, the extrudable composition is extrudable, within the above-defined temperature ranges, through the small diameter capillaries, that is within the die tip, at pressures, as applied by the turning screw of the extruder 12, of no more than about 300 pounds per square inch, gage, (2.1 MPa) for example, from pressures of from about 20 pounds per square inch, gage (0.14 MPa) to about 250 pounds per square inch, gage (1.7 MPa). More specifically, at pressures of from about 50 pounds per square inch, gage to about 250 pounds per square inch, gage (0.34 to 1.7 MPa) for example, from about 125 pounds per square inch, gage to about 225 pounds per square inch, gage (0.86 to 1.6 MPa) Pressures in excess of these values may rupture or break some dies 14. Generally speaking, the extrudable composition is extruded through the capillaries 22 of the die 14 at a rate of from at least about 0.02 gram per capillary per minute to about 1.7 or more grams per capillary per minute, for example, from at least about 0.1 gram per capillary per minute to about 1.25 grams per capillary per minute. More specifically, from at least about 0.3 gram per capillary per minute to about 1.1 grams per capillary per minute.

The die 14 also includes attenuating gas inlets 28 and 30 which are provided with heated, pressurized attenuating gas (not shown) by attenuating gas sources 32 and 34. The heated, pressurized attenuating gas enters the die 14 at the inlets 28 and 30 and follows the path generally designated by the arrows 36 and 38 in Figures 3 and 4 through two chambers 40 and 42 and on through to narrow passageways or gaps 44 and 46 so as to contract the extruded threads 26 as they exit the capillaries 22 of the die 14. The chambers 40 and 42 are designed so that the heated attenuating gas exits the chambers 40 and 42 and passes through the gas passages 44 and 46 to form a stream (not shown) of attenuating gas which exits the die 14. The temperature and pressure of the heated stream of attenuating gas can vary widely. For example, the heated attenuating gas can be applied at a temperature of from about 100 degrees Centigrade to about 400 degrees Centigrade, more specifically from about 200 degrees Centigrade to about 350 degrees Centigrade. The heated attenuating gas can be applied at a pressure of from about 0.5 pounds per square inch, gage to about 20 pounds per square inch, gage, (3400 to 1.4×10^5 Pa), more specifically from about 1 pound per square inch, gage to about 10 pounds per square inch, gage (6900 to 6.9×10^4 Pa).

The position of air plates 48 and 50 which, in conjunction with a die-tip portion 52 of the die 14 define the chambers 40 and 42 and the passageways 44 and 46, may be adjusted relative to the die-tip portion 52 to widen or narrow the width 54 of the attenuating gas passageways 44 and 46 so that the volume of attenuating gas passing through the air passageways 44 and 46 during a given time period can be varied without varying the velocity of the attenuating gas. Furthermore, the air plates 48 and 50 can also be adjusted upwardly and downwardly to effect a "recessed" die-tip configuration or a positive die-tip "stick-out" configuration as discussed in detail below. Generally speaking, it is preferred to utilize attenuating gas pressures of less than about 20 pounds per square inch, (1.4×10^5 Pa) gage in conjunction with air passageway widths, which are usually the same, of no greater than about 0.20 inches. (5.1 cm) Lower attenuating gas velocities and wider air passageway gaps are generally preferred if substantially continuous microfibers are to be produced.

The two streams of attenuating gas converge to form a stream of gas which entrains and attenuates the molten threads 26, as they exit the linearly arranged capillaries 22, into fibers or, depending upon the degree of attenuation, microfibers (also designated 26) of a small diameter, to a diameter less than the diameter of the capillaries 22. Generally speaking, the attenuating gas may be applied to the molten threads 26 at a temperature of from at least about 100 degrees Centigrade to about 400 degrees Centigrade, for example, from at least about 200 degrees Centigrade to about 350 degrees Centigrade and at pressures of from at least about 0.5 pounds per square inch, gage to about 20 pounds per square inch, gage ($3400-1.4 \times 10^5$ Pa) or more, for example, from about 1 pound per square inch, gage to about 10 pounds per square inch, gage. (6900- 6.9×10^4 Pa) The gas-borne microfibers 26 are blown, by the action of the attenuating gas, onto a collecting arrangement which, in the embodiment illustrated in Figure 1, is a foraminous endless belt 56 conventionally driven by rollers 57.

Figure 1 illustrates the formation of substantially continuous microfibers 26 on the surface of the belt 56. However, the microfibers 26 can be formed in a substantially discontinuous fashion as illustrated in Figure 5 by varying the velocity of the attenuating gas, the temperature of the attenuating gas and the volume of attenuating gas passing through the air passageways in a given time period. Other foraminous arrangements such as an endless belt arrangement may be utilized. The belt 56 may also include one or more vacuum boxes (not shown) located below the surface of the foraminous belt 56 and between the rollers 57. The microfibers 26 are collected as a fibrous nonwoven elastomeric web 18 on the surface of the drum 56 which is rotating as indicated by the arrow 58 in Figure 1. The vacuum boxes assist in retention of the microfibers 26 on the surface of the belt 56. Typically the tip 24 of the die tip portion 52 of the meltblowing die 14 is from about 4 inches to about 24 inches (10-61 cm) from the surface of the foraminous endless belt 56 upon which the microfibers 26 are collected. The thus-collected, entangled microfibers 26 form a coherent, i.e. cohesive, fibrous nonwoven elastomeric web 18 which may be removed from the foraminous endless belt 56 by a pair of pinch rollers 60 and 62 which may be designed to press the entangled fibers of the web 18 together to improve the integrity of the web 18. Thereafter, the web 18 may be transported by a conventional arrangement to a wind-up roll (not shown) for storage. Alternatively, the web 18 may be removed directly from the belt 56 by the wind-up roller. The web 18 may be

pattern-embossed as by ultrasonic embossing equipment (not shown) or other embossing equipment, such as, for example, the pressure nip formed between a heated calender and anvil roll (not shown).

Referring now to Figure 3, it can be seen that the meltblowing die 14 includes a base portion 64 and a die tip portion 52 which generally centrally extends from the base portion 64. The centrally located die tip portion 52 is inwardly tapered to a "knife-edge" point which forms the tip 24 of the die tip portion 52 of the die 14. In order to increase the pressures of extrusion which the die 14 can withstand during operation it is preferred for the base portion 64 and die-tip portion 52 to be formed from a single block of metal which surrounds the extrusion slot 20 and the extrusion capillaries 22. The die 14 also includes two air plates 48 and 50, discussed above, which are secured, by conventional means, to the base portion 64 of the die 14. The air plate 48, in conjunction with the die tip portion 52 of the die 14, defines the chamber 40 and the attenuating gas air passage or gap 44. The air plate 50, in conjunction with the die tip portion 52, defines the chamber 42 and the air passageway or gap 46. Air plate 48 and air plate 50 terminate, respectively, in air plate lip 66 and air plate lip 68. In the configuration illustrated in Figure 3, the knife-edge point which forms the tip 24 of the die tip portion 52 of the die 14 is recessed inwardly of the plane formed by the air plate lips 66 and 68. In this configuration the perpendicular distance between the plane formed by the lips 66 and 68 and the tip 24 of the die tip portion 52 is sometimes referred to by those in the art as a "negative stick-out" or a "recessed" die tip configuration. If the tip of the die tip portion 52 of the die 14 were configured to protrude outwardly beyond the plane formed by the lips 66 and 68 of the air plates 48 and 50, as is illustrated in Figure 4, such a configuration is referred to, by those in the art, as a "positive stick-out" of the tip 24 of the die tip 52. In the examples discussed below negative numbers are utilized with die tip 52 "stick-out" distances when tip 24 of the die tip 52 is recessed with regard to the plane formed by the lips 66 and 68 of the air plates 48 and 50. If the tip 24 of the die tip 52 is configured so that it protrudes beyond the plane formed by the lips 66 and 68 of the air plates 48 and 50, the die tip "stick-out" distances are given in positive numbers. Both positive and negative die tip "stick-out" values were obtained in the examples by measuring the perpendicular distance between the plane formed by the lips 66 and 68 of the air plates 48 and 50 and the knife-edge point which forms the tip 24 of the die tip portion 52 of the die 14. In other words, the closest distance between the point 24 and the plane formed by the lips 66 and 68, as defined above. It should also be noted that, unless otherwise stated, the term "air gap or width," as used herein, is the perpendicular, i.e. minimum, width 54 of either of the air passages 44 and 46. These widths are normally arranged to be identical.

In some situations it may be desirable to incorporate discreet particles of one or more solid materials into the extruded threads 26 prior to their collection as a nonwoven elastomeric web 18. For example, it may be desirable to incorporate one or more fibers such as cotton fibers, wood pulp fibers, polyester fibers or other types of fibers or particulates into the threads 26. Blends of two or more of such fibers or particulates can be incorporated. This may be accomplished by utilization of a conforming apparatus such as is illustrated schematically in Figure 5 at 70. Several types of conforming arrangements are well-known to those in the art and one such arrangement is represented by the apparatus disclosed in U.S. patent 4,100,432 to Anderson et al. Figure 5 illustrates that, after formation of the microfibers 26, a stream of secondary fibers or particulates 72 is generally uniformly injected into the stream of microfibers 26. Distribution of the secondary fibers 72 generally uniformly throughout the stream of microfibers 26 is preferably accomplished by merging a secondary gas stream (not shown) containing the secondary fibers 72 with the stream of microfibers 26. Apparatus for accomplishing this merger includes a conventional picker roll 74 which has a plurality of teeth 76 that are adapted to separate a matt or batt of secondary fibers 78 into the individual secondary fibers 72. The matt or batt of secondary fibers 78 which is fed to the picker roll 74 may be a sheet of pulp fibers (if a two component mixture of elastomeric fibers and pulp fibers is desired), a matt or batt of staple fibers (if a two component mixture of elastomeric fibers and staple fibers is desired) or both a sheet of pulp fibers and a matt or batt of staple fibers (if a three component mixture of elastomeric fibers, pulp fibers and staple fibers desired). Other combinations of one or more staple fibers and/or one or more pulp fibers may be utilized. The sheets or matts of secondary fibers 72 are fed to the picker roll 74 by a roller arrangement 80. After the teeth 76 of the picker roll 74 have separated the sheet or matt 78 into separate secondary fibers 72 the individual secondary fibers 72 are conveyed toward the meltdown stream 26 of elastomeric fibers through a forming duct or nozzle 82. A housing 84 encloses the picker roll 74 and provides a passageway or gap 86 between the housing 84 and the surface of the picker roll 74. A gas (not shown), preferably air, is supplied to the passageway or gap 86 between the surface of the picker roll 74 and the housing 84 by way of a gas duct 88. The gas duct 88 preferably enters the passageway or gap 86 generally at the junction 90 of the forming duct or nozzle 82 and the passageway 86. The gas is supplied in sufficient quantity to serve as a medium for conveying the secondary fibers 72 from the teeth 76 of the picker roll 74 and through the forming duct or nozzle 82 at a velocity approaching that of the teeth 76 of the picker roll 74.

As an aid in maintaining satisfactory secondary fiber 72 velocity, the forming duct or nozzle 82 is desirably positioned so that its longitudinal axis is substantially parallel to a plane which is tangent to the surface of the picker roll 74 at the junction 90 of the forming duct or nozzle 82 with the gap 86. As a result of this arrangement the velocity of the secondary fibers 72 is not substantially changed by contact of the secondary fibers 72 with the walls of the forming duct or nozzle 82. If the secondary fibers 72 remain in contact with the teeth 76 of the picker roll 74 after they have been separated from the matt or sheet 78, the axis of the forming duct or nozzle 82 may be adjusted appropriately to be aligned in the direction of secondary fiber 72 velocity at the point where the secondary fibers 72 disengage from the teeth 76 of the picker roll 74. If desired, the disengagement of the secondary fibers 72 with the teeth 76 of the picker roll 74 may be assisted by application of a pressurized gas,

i.e., air, through duct 92.

The height 94 of the forming duct or nozzle 82 with respect to the die tip 24 may be adjusted to vary the properties of the coformed product. Variation of the distance 96 of the tip 98 of the nozzle 82 from the die tip 24 will also achieve variations in the final coformed product. The height 94 and distance 96 values will also vary with the material being added to the microfibers 26. The width of the forming duct or nozzle 82 along the picker roll 74 and the length 100 that the forming duct or nozzle 82 extends from the picker roll 74 are also important in obtaining optimum distribution of the secondary fibers 72 throughout the stream of meltblown microfibers 26. Preferably, the length 100 of the forming duct or nozzle 82 should be as short as equipment design will allow. The length 100 is usually limited to a minimum length which is generally equal to the radius of the picker roll 74. Preferably, the width of the forming duct or nozzle 82 should not exceed the width of the sheets or mats 78 that are being fed to the picker roll 74.

Figure 5 further illustrates that the gas stream carrying the secondary fibers 72 is preferably moving in a direction which is generally perpendicular to the direction of movement of the stream of the microfibers 26 at the point of merger of the two gas streams. Other angles of merger of the two streams may be utilized. The velocity of the gas stream carrying the secondary fibers 72 is usually adjusted so that it is less than the velocity of the gas stream which attenuates the microfibers 26. This allows the streams, upper merger and integration thereof, to flow in substantially the same direction as that of the stream of microfibers 26. Indeed, the merger of the two streams is preferably accomplished in a manner which is somewhat like an aspirating effect whereby the stream of a secondary fiber 72 is drawn into the stream of microfibers 26. It is also preferred that the velocity difference between the two gas streams be such that the secondary fibers 72 are integrated into the microfibers 26 in a turbulent manner so that the secondary fibers 72 become thoroughly mixed with the microfibers 26. In general, increasing the velocity differential between the two streams produces a more homogeneous integration of the secondary fibers 72 into the microfibers 26 and decreases in the velocity differential between the two streams are generally expected to produce concentrated areas of secondary fibers 72 within the microfibers 26. Generally, for increased production rates it is preferred for the gas stream which entrains and attenuates the stream of microfibers 26 to have an initial high velocity, for example from about 200 feet to about 1,000 feet per second ($61-305\text{ms}^{-1}$) and for the stream of gas which carries the secondary fibers 72 to have an initial low velocity, for example from about 50 to about 200 feet per second. Of course, after the stream of gas that entrains and attenuates the extruded threads 26 into elastomeric microfibers exists the air passageways 44 and 46 of the meltblowing die 14 it immediately expands and decreases in velocity.

Upon merger and integration of the stream of secondary fibers 72 into the stream of microfibers 26 to generally uniformly distribute the secondary fibers 72 throughout the stream of meltblown fibers 26, as discussed above, a composite stream 102 of microfibers 26 and secondary fibers 72 is formed. The microfibers 26 may still be semi-molten and tacky at the time of incorporation of the secondary fibers 72 into the microfibers 26, and, in such a situation, the secondary fibers 72 are not only mechanically entangled within the microfibers 26 but also usually become thermally bonded to the microfibers 26. However, if the microfibers 26 are not semi-molten and tacky at the time of incorporation of the secondary fibers 72 therein, the secondary fibers 72 will only be mechanically entangled within the microfibers 26.

In order to convert the composite stream 102 of microfibers 26 and secondary fibers 72 into a fibrous nonwoven elastomeric web 18 of elastomeric microfibers 26 having the secondary fibers 72 generally uniformly distributed throughout and, if desired, bonded to the microfibers 26 of the web 18, a collecting device is located in the path of the composite stream 102. The collecting device may be a rotating belt 56 as described with respect to Figure 1 upon which the composite stream 102 impacts to form the web 18. Preferably, the external surface of the rotating drum is porous and the rotating drum includes a conventional vacuum arrangement (not shown) which assists in retaining the composite stream 102 on the external surface of the drum. Other collecting devices are well-known to those of skill in the art and may be utilized in place of the rotating belt 56, for example, a porous rotating drum arrangement could be utilized. Thereafter, the web 18 may be removed from the belt 56 by a pair of nip rollers (now shown) in an arrangement equivalent to that illustrated in Figure 1. Thereafter, the web 18 may be transported by a conventional arrangement to a wind-up roller (not shown) for storage. Alternatively, the web 18 may be removed directly from the belt 56 by the wind-up roller.

Depending on the characteristics desired of the coformed fibrous nonwoven elastomeric web the web can include (1) from at least about 20 percent, by weight, of a fibrous nonwoven elastic web of microfibers as defined herein, for example microfibers comprising from (a) at least about 10 percent, by weight, of an A-B-A' block copolymer where "A" and "A'" are each a thermoplastic endblock which includes a styrenic moiety and where "B" is an elastomeric poly (ethylene-butylene) midblock with (b) from greater than 0 percent, by weight, up to about 90 percent, by weight, of a polyolefin which, when blended with the A-B-A' block copolymer and subjected to an effective combination of elevated temperature and elevated pressure conditions, can be extruded in blended form, with the A-B-A' block copolymer and (2) from greater than 0 percent, by weight, to about 80 percent, by weight, of at least one secondary fiber generally uniformly distributed throughout the fibrous nonwoven elastomeric web. The fibrous nonwoven elastomeric web can be formed from a block copolymer/polyolefin blend within any of the above-mentioned blend ranges. Additionally, the secondary fibers can form from about 30 percent, by weight, to about 70 percent, by weight, of the coformed web, even more specifically the secondary fibers can form from about 50 percent, by weight, to about 70 percent, by weight, of the coformed web.

The picker roll 74 may be replaced by a conventional particulate injection system to make a fibrous nonwoven

elastomeric web 18 containing various particulates. A combination of both coformed fibers and particulates could be added to the microfibers 26 prior to their formation into a fibrous nonwoven elastomeric web 18.

Throughout the various examples discussed herein, a variety of meltblowing die extruders and configurations were utilized in a variety of combinations to illustrate the broad applicability of the present invention. Specific details of the meltblowing dies and extruders are, for ease of reference, tabulated in Tables II and III below:

TABLE II

Meltblowing dies

Die No.	Extent of Capillary Array (inches/cm)	Capillaries per inch of die extent (per cm)	Capillary diameter (inches/mm)	Capillary length (inches/mm)
#1	20 (51)	15 (6)	0.018 (0.46)	0.14 (3.5)
#2	20 (51)	30 (12)	0.0145 (0.37)	0.113 (2.9)
#3	1-5/8 (4.1)	20 (8)	0.0145 (0.37)	0.113 (2.9)
#4	1-5/8 (4.1)	9 (3.5)	0.0145 (0.37)	0.113 (2.9)

TABLE III

Extruders

Extruder Designation	Type	Diameter (inches/mm)	Temperature Zones	Length/Diameter Ratio
A	Johnson	1.5 (38)	3	24:1
B	Brabender	0.75 (19)	3	24:1

Meltblowing dies 3 and 4 are high pressure dies. Reference will be made to certain combinations of meltblowing dies and extruders with, for example, a designation of "A2" meaning that extruder "A" was utilized in conjunction with meltblowing die "2".

Example I

A fibrous nonwoven elastic web was formed by utilizing the techniques illustrated in Figure 4 to combine cotton fibers with meltblown microfibers formed from a blend of 60 percent, by weight, of a A-B-A' block copolymer having polystyrene "A" and "A'" end blocks and a poly (ethylene-butylene) "B" midblock (obtained from the Shell Chemical Company under the trade designation KRATON GX 1657) and 40 percent, by weight, of a polyethylene (obtained from U.S.I. Chemical Company under the trade designation PE Na601).

Meltblowing of the fibrous nonwoven elastic web was accomplished by extruding the blend of materials through extruder/die arrangement A1, as defined herein. The blend was extruded through the capillaries at a rate of about 1.36 grams per capillary per minute at a temperature of about 314.4 degrees Centigrade. The extrusion pressure exerted upon the blend in the die tip was measured as 200 pounds per square inch, gage, (1.4×10^6 Pa) giving a viscosity for the blend of about 153 poise in the die capillaries. The die tip configuration was adjusted so that it was recessed about 0.090 (-0.090 die tip stick-out) inches (2.3mm from the plane of the external surface of the lips of the air plates which form the attenuating air passageways on either side of the row of capillaries. The air plates were adjusted so that the two attenuating air passages, one on each side of the extrusion capillaries, formed passageways having air gaps, i.e. widths, of about 0.067 inches. (1.7mm) It should be noted that the air passageway or gap configuration utilized in this Example 1 differed slightly from the configuration illustrated in Figure 3 in that the angle formed by the die tip portion 52, that is the angle which the capillaries 22 bisect, is 90 degrees and, therefore, the air gaps 44 and 46 are wider near the tip 24 of the die tip 52 than at the areas 40 and 42. In other words, the air gaps 44 and 46, of this die configuration, widen as opposed to narrowing as the attenuating air progresses as indicated by the arrows 36 and 38. Forming air for meltblowing the blend was supplied to the air passageways at a temperature of about 341.1 degrees Centigrade and at a pressure of about 4 pounds per square inch, gage. (2.8×10^4 Pa) The meltblown fibers thus formed were blown toward a forming screen which was approximately 11 inches from the die tip. (28cm)

Utilizing the conventional coforming techniques as illustrated in Figure 2, bleached cotton fibers obtained from Cotton Incorporated of N.Y. State and having a length of about one and one-half inches (4cm) were incorporated into the stream of meltblown microfibers prior to their deposition upon the forming screen. The cotton fibers were first formed, by a Rando Webber mat forming apparatus, into a mat having an approximate basis weight of about 75 grams per square meter. The mat was fed to the picker roll by a picker roll feed roll which was positioned about 0.005 inches (0.13mm) from the surface of the picker roll. The picker roll was rotating at a rate of about 3,000 revolutions per minute and fiber transporting air was supplied to the picker roll at a pressure of about 4 pounds per square inch, gage (2.8×10^4 Pa). Actual measurement of the position of the nozzle of the coform apparatus with respect to the stream of meltblown microfibers was not made. However, it is believed that the nozzle of the coforming apparatus was positioned about 2 inches (5cm) below the die tip of

the meltblowing die and about 2 inches (5mm) back from the die tip of the meltblowing die. This procedure provided a fibrous nonwoven elastomeric web having a width (cross-machine direction) of about twenty (20) inches (51cm) which was composed of a blend of about 70 percent, by weight, of the elastomeric meltblown microfibers and about 30 percent, by weight, of the cotton fibers.

- 5 A three inch wide by five inch long sample (8 × 13cm) of the fibrous nonwoven web formed by the procedure of Example I was tested for elongation in both the machine direction and the cross-machine direction. The machine direction tests were conducted on a sample which was cut from the 20 inch wide (51cm) web and measured three inches (8cm) in the cross-machine direction and five inches (13cm) in the machine direction. The cross-machine direction tests were conducted on a sample which was cut from the 20 inch wide (51cm) web and measured three inches (8cm) in the machine direction and five inches (13cm) in the cross machine direction. Each sample was placed lengthwise in an Instron Model 1122 testing apparatus having an initial jaw setting of about three inches (8cm) and which stretched the samples at a rate of about ten inches (25cm) per minute to a length which was 150 percent, that is one and one-half times, the length of the unstretched sample, i.e. 50 percent elongation. The load, in grams, necessary to achieve the 150 percent length was measured and the sample was maintained at the 150 percent length (50 percent elongation) for one (1) minute. At the end of the one minute period, the load, in grams, necessary to maintain the length of the sample at the 150 length (50 percent elongation) was measured and the length of the sample was increased from 150 percent to 200 percent of the original unstretched length of the sample, that is twice the original length of the unstretched sample, i.e. 100 percent elongation. The load, in grams, necessary to achieve the 200 percent length was measured and the sample was then maintained at the 200 percent length for a one minute. At the end of the second one minute period the load, in grams, necessary to maintain the length of the sample at 200 percent (100 percent elongation) was measured. Thereafter, all load was removed from the sample and the percent of permanent deformation of the sample was measured. (For hypothetical illustration only, if a three cm sample returned to 3.3 cm the percent of permanent deformation would be 10 percent, i.e., 0.3/3.0.) After measurement of the percent of permanent deformation, the sample was elongated to break (i.e., rupture) and the peak load, in grams, encountered during elongation of the sample to break and the percent of elongation of the sample at break was measured. The percent of elongation at break is reported as a percent of the unstretched length of the sample. For example, if a sample having an unstretched length of 3 cm broke at 9 cm its elongation at break value would be 200 percent.
- 30 The results are indicated in the following Table IV, below, where it can be seen that the load reduction after the one (1) minute waiting period decreased in each case and that the peak load was about that of the initial load at 100 percent elongation. These results demonstrate the elastomeric properties of the samples since to obtain a meaningful understanding of the elastomeric properties of material it is valuable to know both the percent of stretch to which the sample was subjected and the amount of permanent set which the material retained.

TABLE IV

	<i>Machine Direction</i>	<i>Cross-Machine Direction</i>	
40 Initial Load at the 150% length (50% elongation)	411 grams	209 grams	40
Load at 150% length after 1 minute (50% elongation)	214 grams	113	
45 Initial Load at the 200% length (100% elongation)	420 grams	258	45
Load at the 200% length after 1 minute (100% elongation)	240 grams	143 grams	
% Permanent Deformation	16%	21%	
50 Peak Load Encountered	393 grams	266 grams	50
% Elongation at Break	171%	225%	

Example II

A fibrous nonwoven elastic web was formed by meltblowing a blend of 90 percent, by weight, of an A-B-A' block copolymer having polystyrene "A" and "A'" endblocks and a poly (ethylene-butylene) "B" midblock (obtained from the Shell Chemical Company under the trade designation KRATON GX 1657) and 10 percent, by weight, of a polyethylene (obtained from U.S.I. Chemical Company under the trade designation PE Na601).

Meltblowing of the fibrous nonwoven elastic web was accomplished by extruding the blend of materials through extruder/die arrangement B4 as defined herein. The blend was extruded through the capillaries at a rate of about 0.36 grams per capillary per minute at a temperature of about 322.8 degrees Centigrade. The extrusion pressure exerted upon the blend in the die tip was measured as 450 pounds per square inch, gage. (3.1×10^6 Pa) The die tip configuration was adjusted so that it extended about 0.010 inches (0.25mm) (0.010 inch die tip stick-out) beyond the plane of the external surface of the lips of the air plates which form the forming air passageways on either side of the capillaries. The air plates were adjusted so that the two forming air passageways, one on each side of the extrusion capillaries, formed air passageways of a width or gap of about

0.060 inches (1.5mm). Forming air for meltblowing the blend was supplied to the air passageways at a temperature of about 335.6 degrees Centigrade and at a pressure of about 1.5 pounds per square inch, gage. (10,000Pa) The viscosity of the blend was calculated at 651 poise in the capillaries. The meltblown fibers thus formed were blown onto a forming screen which, while not actually measured, is believed to have been approximately 12 inches from the die tip. (30cm)

5

Example III

A fibrous nonwoven elastic web was formed by meltblowing a blend of 80 percent, by weight, of an A-B-A' block copolymer having polystyrene "A" and "A'" endblocks and a poly (ethylene-butylene) "B" midblock (obtained from the Shell Chemical Company under the trade designation KRATON GX 1657) and 20 percent, by weight, of a polyethylene (obtained from U.S.I. Chemical Company under the trade designation PE Na601).

Meltblowing of the fibrous nonwoven elastic web was accomplished by extruding the blend of materials through extruder/die arrangement B4 as defined herein. The blend was extruded through the capillaries at a rate of about 0.43 grams per capillary per minute at a temperature of about 322.8 degrees Centigrade. The extrusion pressure exerted upon the blend in the die tip was measured as 472 pounds per square inch, gage. (3.3×10^6 Pa) The die tip configuration was adjusted so that it extended about 0.010 inches (0.25mm) (0.010 inch die tip stick-out) beyond the plane of the external surface of the lips of the air plates which form the air passages on either side of the capillaries. The air plates were adjusted so that the two air passages, one on each side of the extrusion capillaries, formed air passageways of a width or gap of about 0.60 inches. (1.5mm) Forming air for meltblowing the blend was supplied to the air passageways at a temperature of about 325.0 degrees Centigrade and at a pressure of about 2.0 pounds per square inch, gage. (1.4×10^4 Pa) The viscosity of the blend was calculated at 572 poise in the capillaries. The meltblown fibers thus formed were blown onto a forming screen which, while not actually measured, is believed to have been approximately 12 inches from the die tip. (30cm)

25 Example IV

A fibrous nonwoven elastic web was formed by meltblowing a blend of 70 percent, by weight, of an A-B-A' block copolymer having polystyrene "A" and "A'" endblocks and a poly (ethylene-butylene) "B" midblock (obtained from the Shell Chemical Company under the trade designation KRATON GX 1657) and 30 percent, by weight, of a polyethylene (obtained from U.S.I. Chemical Company under the trade designation PE Na601).

Meltblowing of the fibrous nonwoven elastic web was accomplished by extruding the blend of materials through extruder/die arrangement B4, as defined herein. The blend was extruded through the capillaries at a rate of about 0.43 grams per capillary per minute at a temperature of about 322.8 degrees Centigrade. The extrusion pressure exerted upon the blend in the die tip was measured as 375 pounds per square inch, gage. (2.6×10^6 Pa) The die tip configuration was adjusted so that it extended about 0.010 inches (0.25mm) (0.010 inch die tip stick-out) beyond the plane of the external surface of the lips of the air plates which form the air passageways on either side of the capillaries. The air plates were adjusted so that the two air passageways, one on each side of the extrusion capillaries, formed air passageways of a width or gap of about 0.060 inches. (1.5mm) Forming air for meltblowing the blend was supplied to the air passageways at a temperature of about 325.0 degrees Centigrade and at a pressure of about 2.0 pounds per square inch, gage. (1.4×10^4 Pa) The viscosity of the blend was calculated at 454 poise in the capillaries. The meltblown fibers thus formed were blown onto a forming screen which, while not actually measured, is believed to have been approximately 12 inches from the die tip. (30cm)

Example V

A fibrous nonwoven elastic web was formed by meltblowing a blend of 70 percent, by weight, of an A-B-A' block copolymer having polystyrene "A" and "A'" endblocks and a poly (ethylene-butylene) "B" midblock (obtained from the Shell Chemical Company under the trade designation KRATON GX 1657) and 30 percent, by weight, of a polyethylene (obtained from U.S.I. Chemical Company under the trade designation PE Na601).

Meltblowing of the fibrous nonwoven elastic web was accomplished by extruding the blend of materials through extruder/die arrangement B4, as defined herein. The blend was extruded through the capillaries at a rate of about 0.64 grams per capillary per minute at a temperature of about 322.2 degrees Centigrade. The extrusion pressure exerted upon the blend in the die tip was measured as 480 pounds per square inch, gage. (3.3×10^6 Pa). The die tip configuration was adjusted it extended about 0.010 inches (0.25mm) (0.010 inch die tip stick out) beyond the plane of the external surface of the lips of the air plates which form the air passageways on either side of the capillaries. The air plates were adjusted so that the two air passageways, one on each side of the extrusion capillaries, formed air passageways of a width or gap of about 0.060 inches (1.5mm). Forming air for meltblowing the blend was supplied to the air passageways at a temperature of about 324.4 degrees Centigrade and at a pressure of about 4.5 pounds per square inch, gage (31,000Pa). The viscosity of the blend was calculated at 391 poise in the capillaries. The meltblown fibers thus formed were blown onto a forming screen which, while not actually measured, is believed to have been approximately 12 inches from the die tip (30cm).

Example VI

A fibrous nonwoven elastic web was formed by meltblowing a blend of 60 percent, by weight, of an A-B-A' block copolymer having polystyrene "A" and "A'" endblocks and poly (ethylene-butylene) "B" midblock (obtained from the Shell Chemical Company under the trade designation KRATON GX 1657) and 40 percent,

65

by weight, of a polyethylene (obtained from U.S.I. Chemical Company under the trade designation PE Na601).

Meltblowing of the fibrous nonwoven elastic web was accomplished by extruding the blend of materials through extruder/die arrangement B4, as defined herein. The blend was extruded through the capillaries at a rate of about 0.36 grams per capillary per minute at a temperature of about 323.9 degrees Centigrade. The extrusion pressure exerted upon the blend in the die tip was measured as 240 pounds per square inch, gage (1.7×10^6 Pa). The die tip configuration was adjusted so that it extended about 0.010 inches (0.25mm) (0.010 inch die tip stick-out) beyond the plane of the external surface of the lips of the air plates which form the air passageways on either side of the capillaries. The air plates were adjusted so that the two air passageways, one on each side of the extrusion capillaries, formed air passageways of a width or gap of about 0.060 inches (1.5mm). Forming air for meltblowing the blend was supplied to the air passageways at a temperature of about 324.4 degrees Centigrade and at a pressure of about 1.5 pounds per square inch, gage (10,000Pa). The viscosity of the blend was calculated at 347 poise in the capillaries. The meltblown fibers thus formed were blown onto a forming screen which, while not actually measured, is believed to have been approximately 12 inches from the die tip (30cm).

15 Example VII

A fibrous nonwoven elastic web was formed by meltblowing a blend of 60 percent, by weight, of an A-B-A' block copolymer having polystyrene "A" and "A'" endblocks and a poly (ethylene-butylene) "B" midblock (obtained from the Shell Chemical Company under the trade designation KRATON G 1652) and 40 percent, by weight, of a polyethylene (obtained from U.S.I. Chemical Company under the trade designation PE Na601).

Meltblowing of the fibrous nonwoven elastic web was accomplished by extruding the blend of materials through extruder/die arrangement B4, as defined herein. The blend was extruded through the capillaries at a rate of about 0.36 grams per capillary per minute at a temperature of about 323.9 degrees Centigrade. The extrusion pressure exerted upon the blend in the die tip was measured as 220 pounds per square inch, gage (1.5×10^6 Pa). The die tip configuration was adjusted so that it extended about 0.010 inches (0.25mm) (0.010 inch die tip stick-out) beyond the plane of the external surface of the lips of the air plates which form the air passageways on either side of the capillaries. The air plates were adjusted so that the two air passageways, one each side of the extrusion capillaries, formed air passageways of a width or gap of about 0.060 inches (1.5mm). Forming air for meltblowing the blend was supplied to the air passageways at a temperature of about 335.0 degrees Centigrade and at a pressure of about 1.5 pounds per square inch, gage (10,000Pa). The viscosity of the blend was calculated at 318 poise in the capillaries. The meltblown fibers thus formed were blown onto a forming screen which, while not actually measured, is believed to have been approximately 12 inches from the die tip (30cm).

Example VIII

A fibrous nonwoven elastic web was formed by meltblowing a blend of 60 percent, by weight, of an A-B-A' block copolymer having polystyrene "A" and "A'" endblocks and a poly (ethylene-butylene) "B" midblock (obtained from the Shell Chemical Company under the trade designation KRATON GX 1657) and 40 percent, by weight, of a polypropylene (obtained from The Himont Company under the trade designation PC-973).

Meltblowing of the fibrous nonwoven elastic web was accomplished by extruding the blend of materials through extruder/die arrangement B4, as defined herein. The blend was extruded through the capillaries at a rate of about 0.32 grams per capillary per minute at a temperature of about 324.4 degrees Centigrade. The extrusion pressure exerted upon the blend in the die tip was measured as 380 pounds per square inch, gage (2.6×10^6 Pa). The die tip configuration was adjusted so that it extended about 0.010 inches (0.25mm) (0.010 inch die tip stick-out) beyond the plane of the external surface of the lips of the air plates which form the air passageways on either side of the capillaries. The air plates were adjusted so that the two air passageways, one on each side of the extrusion capillaries, formed air passageways of a width or gap of about 0.060 inches (1.5mm). Forming air for meltblowing the blend was supplied to the air passageways at a temperature of about 337.8 degrees Centigrade and at a pressure of about 2.0 pounds per square inch, gage (14,000Pa). The viscosity of the blend was calculated at 619 poise in the capillaries. The meltblown fibers thus formed were blown onto a forming screen which, while not actually measured, is believed to have been approximately 12 inches from the die tip (30cm).

Comparative example IX

A fibrous nonwoven elastic web was formed by meltblowing a composition of 100 percent, by weight, of an A-B-A' block copolymer having polystyrene "A" and "A'" endblocks and a poly (ethylene-butylene) "B" midblock (obtained from the Shell Chemical Company under the trade designation KRATON GX 1657).

Meltblowing of the fibrous nonwoven elastic web was accomplished by extruding the composition through extruder/die arrangement B4, as defined herein. The composition was extruded through the capillaries at a rate of about 0.32 grams per capillary per minute at a temperature of about 324.4 degrees Centigrade. The extrusion pressure exerted upon the composition in the die tip was measured as greater than 505 (off scale of the pressure probe) pounds per square inch, gage (3.5MPa). The die tip configuration was adjusted so that it extended about 0.010 inches (0.25mm) (0.010 inch die tip stick-out) beyond the plane of the external surface of the lips of the air plates which form the air passageways on either side of the capillaries. The air plates were adjusted so that the two air passageways, one on each side of the extrusion capillaries, formed air passageways of a width or gap of about 0.060 inches (1.5mm). Forming air for meltblowing the composition was supplied to the air passageways

at a temperature of about 337.8 degrees Centigrade and at a pressure of about 2.0 pounds per square inch, gage (14kPa). The viscosity of the composition was calculated as greater than 823 (ff scale) poise in the capillaries because the pressure probe was off scale. The meltblown fibers thus formed were blown into a forming screen which, while not actually measured, is believed to have been approximately 12 inches from the die tip (30cm).

5 Table V summarizes the variables utilized in examples 2 through 9.

5

TABLE V

10 Example	2	3	4	5	6	7	8	9	10
Extruder/Die Arrangement ¹	B4	B4	B4	B4	B4	B4	B4	B4	
Material ²	90A/10B	80A/20B	70A/30B	70A/30B	60A/40B	60C/40B	60A/40D	100A	
15 Extrusion Rate ³	0.36	0.43	0.43	0.64	0.36	0.36	0.32	0.32	15
Extrusion Temperature ⁴	322.8	322.8	322.8	322.2	323.9	323.9	324.4	324.4	
Extrusion Pressure ⁵	450 (3.1)	472 (3.3)	375 (2.6)	480 (3.3)	240 (1.7)	220 (1.5)	380 (2.6)	505+ (3.5+)	
20 Die Tip Stick-Out ⁶	0.010 (0.25)								20
Air Passageway Gap ⁷	0.060 (1.5)								
Air Temperature ⁸	335.6	325.0	325.0	324.4	334.4	335.0	337.8	337.8	
25 Air Pressure ⁹	1.5 (10)	2.0 (14)	2.0 (14)	4.5 (31)	1.5 (10)	1.5 (10)	2.0 (14)	2.0 (14)	25
Material Viscosity ¹⁰	651	572	454	391	347	318	619	823+	
Die-Tip to Forming Screen Distance ¹¹	12 (30)								30

The following footnotes apply to Table V:

¹ = as defined herein

² = A = KRATON GX 1657 (Shell)

35 B = Polyethylene PE Na601 (U.S.I.)

C = KRATON G 1652 (Shell)

D = Polypropylene PC-973 (Himont)

90A/10B = 90 percent, by weight, A blended with 10 percent, by weight, of B

³ = in grams per capillary per minute

40 ⁴ = in degrees Centigrade

⁵ = in pounds per square inch, gage in the capillaries (MPa)

⁶ = negative values indicate recessed die tip arrangement, in inches (mm)

⁷ = in inches (mm)

⁸ = in degrees Centigrade

45 ⁹ = in pounds per square inch, gage (kPa)

¹⁰ = in poise

¹¹ = in inches, not actually measured (cm)

45

The elastomeric characteristics of the fibrous nonwoven webs formed in examples 2, 3, and 6 through 9 were measured. Data was also obtained for one of the 70 percent KRATON GX 1657/30 percent polyethylene blends (examples 4 or 5) but it is not absolutely certain with which example the data is to be associated. It is believed that the data is to be associated with Example 4 and it is so reported. If this assumption were incorrect, the data should be associated with Example 5. The testing was accomplished by utilization of an Instron tensile tester model 1122, which elongated each sample, at a rate of five inches (13cm) per minute, 100 percent, that is 200 percent of the original unstretched machine direction length and then allowed the sample to return to an unstretched condition. This procedure was repeated four (4) times and then each sample was elongated to break or tear. Each sample was two (2) inches wide (5cm) (transverse machine direction) by five (5) inches long (13cm) (machine direction) and the initial jaw separation on the tester was set at one (1) inch (2.5cm). The samples were placed lengthwise in the tester. The data which was obtained is tabulated in Table VI below.

60

60

TABLE VI

					Percent Permanent Set ³	
Example	Stretch Number	MD Strip Tensile ¹	Energy ²			
5	2	1	366	0.498 (56.3)	3.3	5
	2	2	355	0.437 (49.4)	3.7	
	2	3	353	0.430 (48.6)	4.1	
	2	4	351	0.423 (47.8)	4.7	
10	2	5	348	0.416 (47.0)	4.9	10
	2	⁴ to break (758%)	1,760	12.9 (1.46J)	N/A	
	3	1	400	0.537 (60.7)	3.9 ⁵	
15	3	2	388	0.461 (52.1)	5.5	15
	3	3	381	0.442 (49.9)	6.1	
	3	4	378	0.431 (48.7)	6.2	
	3	5	375	0.420 (47.5)	6.7	
	3	⁴ to break (833%)	1,590	14.7 (1.66J)	N/A	
20						20
	4	1	515	0.746 (84.3)	2.8	
	4	2	510	0.655 (74.0)	3.9	
	4	3	505	0.633 (71.5)	4.1	
25	4	4	498	0.622 (70.3)	4.5	25
	4	5	495	0.615 (69.5)	4.5	
	4	⁴ to break (746%)	2,058	18.7 (2.11J)	N/A	
30	6	1	670	0.984 (111)	4.3	30
	6	2	656	0.797 (90.0)	5.1	
	6	3	649	0.763 (86.2)	5.5	
	6	4	638	0.742 (83.8)	6.1	
	6	5	635	0.729 (82.4)	6.1	
35	6	⁴ to break (689%)	1,916	16.8 (1.90J)	N/A	35
	7	1	565	0.795 (89.8)	2.8	
	7	2	550	0.652 (73.7)	3.9	
40	7	3	542	0.623 (70.4)	4.1	40
	7	4	534	0.605 (68.4)	4.1	
	7	5	530	0.594 (67.1)	4.3	
	7	⁴ to break (670%)	1,996	15.3 (1.73J)	N/A	
45						45
	8	1	1,907	3.20 (362)	11.5	
	8	2	1,865	1.63 (184)	14.5	
	8	3	1,824	1.47 (166)	15.0	
	8	4	1,812	1.41 (159)	17.0	
50	8	5	1,792	1.40 (158)	17.0	50
	8	⁴ to break (699%)	4,929	41.0 (4.63J)	N/A	
	9	1	513	0.682 (77.1)	3.7	
55	9	2	506	0.585 (66.1)	4.1	55
	9	3	504	0.569 (64.3)	5.9	
	9	4	497	0.559 (63.2)	4.5	
	9	5	496	0.554 (62.6)	5.9	
	9	⁴ to break (661%)	4,365	23.8 (2.69J)	N/A	
60						60

Footnotes for Table VI

¹ in grams per two inch wide (5cm) sample and reported as an average of two replicate measurements with the average then being normalized to a 100 gram per square meter material according to the formula reported value

$$= (\text{average value}) \times \frac{(100)}{(\text{actual basis weight})}$$

² in inch-pounds (Joules $\times 10^3$) and reported as an average of two replicate measurements with the average then being normalized to a 100 gram per square meter material according to the formula of the immediately preceding footnote 1.

³ as a percent of the unstretched length of the sample and reported as an average of two replicate measurements unless otherwise noted.

⁴ as a percentage increase of the length of the original unstretched sample and reported as an average of two replicate measurements. For example, 100 percent would equal twice the length of the original unstretched sample.

⁵ one measurement only.

Additional examples were conducted with Table VII summarizing the variables utilized in Examples X through XVI.

TABLE VII

Example	10	11	12	13	14	15	16
Extruder/Die Arrangement ¹	A2	A2	A2	A2	A2	A2	A2
Material ²	70A/30B	70A/30B	60A/40B	60A/40B	60A/40B	60A/40B	60A/40B
Extrusion Rate ³	0.302	0.302	0.302	0.302	0.504	0.504	0.504
Extrusion Temperature ⁴	299.0	299.0	295.0	299.4	293.3	295.0	294.4
Extrusion Pressure ⁵	155 (31)	156 (1.1)	93 (0.64)	86 (0.60)	170 (1.2)	160 (1.1)	153 (1.1)
Die Tip Stick-Out ⁶	-0.080 (-2.0)						
Air Passageway Gap ⁷	-0.067 (1.7)						
Air Temperature ⁸	316.7	316.7	311.7	316.1	310.0	308.9	307.2
Air Pressure ⁹	7.0 (48)	3.5 (24)	3.5 (24)	7.0 (48)	3.5 (24)	10.0 (69)	7.0 (48)
Material Viscosity ¹⁰	267	269	160	148	176	165	158
Distance ¹¹ Die-Tip to Forming Screen	8 (20)	8 (20)	8 (20)	8 (20)	12 (30)	12 (30)	12 (30)

The following footnotes apply to Table V:

¹ = as defined herein

² = A = KRATON GX 1657 (Shell)

B = Polyethylene PE Na601 (U.S.I.)

90A/10B = 90 percent, by weight, A blended with 10 percent, by weight, of B

³ = in grams per capillary per minute

⁴ = in degrees Centigrade

⁵ = in pounds per square inch, gage in the capillaries (MPa)

⁶ = negative values indicate recessed die tip arrangement, in inches (mm)

⁷ = in inches (mm)

⁸ = in degrees Centigrade

⁹ = in pounds per square inch, gage (kPa)

¹⁰ = in poise

¹¹ = in inches, approximate values (cm)

Comparison of examples 4 through 6 of Table V with examples 10 through 16 of Table VII reveals that different extrusion pressures and thus different polymer viscosities resulted from examples which were otherwise generally comparable. These viscosity differences may have resulted from the fact that one lot, lot A, of KRATON GX 1657 block copolymer was utilized in examples 2-6, 8 and 9, and a different lot, lot B, of KRATON GX 1657 block copolymer was utilized in examples 10 through 16. In view of these results, the meltflow rate (MFR) of lot A and lot B of the KRATON GX 1657 block copolymer was tested in accordance with ASTM standard D-1238 at 320 degrees Centigrade and using a 2,160 gram load since, generally speaking, higher meltflow rates are associated with lower polymer viscosities. The results of these tests are reported verbatim in Table VIII.

TABLE VIII

MFR ¹		Lot A 98	Lot B 148	
5	Footnote to Table VIII: ¹ = in grams per ten (10) minutes			5
10	The machine direction elongation characteristics of the fibrous nonwoven elastomeric webs formed by the processes detailed in examples 10 through 16 were tested by obtaining a two inch wide (5cm, transverse direction) by five inch long (13cm, machine direction) sample of each material. Each sample was placed lengthwise in an Instron model 1122 tester with an initial jaw separation setting of one inch (2.5cm). The sample was then stretched at a rate of ten (10) inches (25cm) per minute in the machine direction, i.e. lengthwise, to determine the load, in grams, required to elongate each sample 100 percent in the machine direction (L100). That is, the load, in grams, required to elongate each sample to a machine direction length of twice its unstretched machine direction length. Thereafter, each sample was elongated to break in the machine direction and the percent elongation of the sample in the machine direction at break (EB) was measured as a percentage of the unstretched machine direction length of the sample. The peak load (PL), in grams, encountered during elongation of the sample to break was also measured. The L100 and PL results which are reported in Table IX, below, were normalized to a fibrous nonwoven web having a basis weight of 100 grams per square meter by utilizing the following equation			10

$$\text{Normalized Value} = \text{Actual Value} \times \frac{(100)}{(\text{Actual Basis Weight})}$$

Example		10	11	12	13	14	15	16	
25									25
30	L100 ¹	485	495	584	609	505	609	571	30
	EB ²	579	645	509	422	524	355	391	
	PL ³	1,453	1,304	1,227	1,176	898	1,031	1,042	

Footnotes to Table IX:

- ¹ = in grams, for a two inch (5cm) wide sample, normalized to 100 gram per square meter sample
² = in percent of unstretched machine direction length
³ = in grams, for a two inch (5cm) wide sample, normalized to 100 gram per square meter sample

Review of Table V generally reveals that the viscosity of the extrudable composition decreases as the polyolefin content of the composition increases. To further emphasize this fact the viscosity data from Table V are reproduced in Table X, below.

TABLE X

% Tri-block Copolymer		% Polyethylene	Viscosity	
45	100	0	823+ poise	45
	90	10	651 poise	
	80	20	572 poise	
50	70	30	452 poise	50
	60	40	347 poise	

The results of Table X and the other above-mentioned data clearly demonstrate that the viscosity of the extrudable composition decreases rapidly with increasing polyolefin content. Further and surprisingly, the data demonstrate that the elastometric properties of the nonwoven webs formed from the extrudable composition generally approximates the elasticity of the nonwoven webs formed solely from the block copolymer. In fact, the elasticity of the nonwoven materials formed from the extrudable composition remains quite satisfactory even at high polyolefin contents.

60 Example XVII

A fibrous nonwoven elastic web was formed by meltblowing a blend of 50 percent, by weight, of an A-B-A' block copolymer having p-lystyrene "A" and "A'" endblocks and a poly (ethylene-butylene) "B" midblock (obtained from the Shell Chemical Company under the trade designation KRATON G 1652) and 50 percent, by weight, of a polybutene (obtained from Amoco under the trade designation Indopol L-14).

65 Amoco literature states that the Amoco polybutenes are a series of isobutylene-butene copolymers composed

predominantly of high molecular weight mono-olefin (95 percent-100 percent) with the balance being isoparaffins. Typical properties of the L-14 polybutene as stated by Amoco literature are reported in Table XI, below.

5	TABLE XI			5
	<i>Indopol-L-14</i>			
	<i>Test method</i>	<i>L-14</i>		
10	Viscosity	D445		10
	cSt at 38°C (100°F)		27-33	
	cSt at 99°C (210°F)		—	
	Flash Point COC*(°F), Min	D92	138 (280)	
15	API Gravity at 16°C (60°F)	D287	36-39	15
	Color	APHA		
	Haze Free, Max.		70	
	Haze, Max.		15	
	Appearance	Visual	No Foreign Material	
20	Viscosity, SUS at 38°C (100°F)		139	20
	SUS at 99°C (210°F)		42	
	Average Molecular Weight	Vapor Phase Osmometer	320	
25	Viscosity Index	ASTM D567	69	25
	Fire Point COC, °C (°F)	ASTM D92	154 (310)	
	Pour Point, °C (°F)	ASTM D97	-51 (-60)	
	Specific Gravity 15.6/15.6 °C (60/60°F)		0.8373	
	Density, Lb/Gal (gcm ⁻³)		6.97 (0.556)	
30	Ref. Index, N ₂ D	ASTM D1218	1.4680	30
	Acidity, mg KOH/g	ASTM D974	0.03	
	Total sulfur, ppm	X-Ray	6	

Meltblowing of the fibrous nonwoven elastic web was accomplished by extruding the blend of materials through a 0.75 inch diameter Brabender extruder through a meltblowing die having twenty extrusion capillaries per lineal inch of die tip. That is, extruder/die arrangement B3, as defined herein, was utilized. The capillaries each had a diameter of about 0.0145 inches (0.37mm) and a length of about 0.113 inches (2.87mm). The blend was extruded through the capillaries at a rate of about 0.53 grams per capillary per minute at a temperature of about 204 degrees Centigrade. The extrusion pressure exerted upon the blend in the die tip was measured as less than 40 pounds per square inch, gage (2.8×10^5 Pa). The die tip configuration was adjusted so that it extended about 0.010 inches (0.25mm) beyond the plane of the external surface of the lips of the air plates which form the air passageways on either side of the capillaries. The air plates were adjusted so that the two air passageways, one on each side of the extrusion capillaries, formed air passageways of a width or gap of about 0.060 inches (1.5mm). Forming air for meltblowing the blend was supplied to the air passageways at a temperature of about 204 degrees Centigrade and at a very low, unmeasured, pressure of about 1 pound per square inch, gage (7000 Pa). The viscosity of the blend was calculated at about 39 poise in the capillaries.

A considerable amount of smoke was produced during Example XVII and it is believed that this was due to the vaporization of the L-14 material since the temperature of extrusion was higher than the flash point of the material as specified in Table XI. Due to the excessive smoking no material was collected in accordance with the procedures of Example XVII.

Accordingly, the extrusion temperature was reduced to 160 degrees Centigrade and Example XVIII was conducted.

Example XVIII

A fibrous nonwoven elastic web was formed by meltblowing a blend of 50 percent, by weight, of an A-B-A' block copolymer having polystyrene "A" and "A'" endblocks and a poly (ethylene-butylene) "B" midblock (obtained from the Shell Chemical Company under the trade designation KRATON G 1652) and 50 percent, by weight, of a polybutene (obtained from Amoco under the trade designation Indopol L-14).

Meltblowing of the fibrous nonwoven elastic web was accomplished by extruding the blend of materials through a 0.75 inch (19mm) diameter Brabender extruder and through a meltblowing die having twenty extrusion capillaries per lineal inch of die tip (8 per cm). That is, extruder/die arrangement B3, as defined herein, was utilized. The capillaries each had a diameter of about 0.0145 inches (0.37mm) and a length of about 0.113 inches (2.87mm). The blend was extruded through the capillaries at a rate of about 0.53 grams per capillary per minute at a temperature of about 160 degrees Centigrade. The extrusion pressure exerted upon the blend in the die tip was not measured. The die tip configuration was adjusted so that it extended about 0.010 inches

(0.25mm) beyond the plane of the external surface of the lips of the air plates which form the air passageways on either side of the capillaries. The air plates were adjusted so that the two air passageways, one on each side of the extrusion capillaries, formed air passageways of a width or gap of about 0.060 inches (1.5mm). Forming air for meltblowing the blend was supplied to the air passageways at a temperature of about 160 degrees Centigrade and at a very low, unmeasured, pressure of about 1 pound per square inch, gage (7000Pa). The viscosity of the blend could not be calculated because extrusion pressure was not measured. The meltblown fibers thus formed were blown onto a forming screen which while not actually measured is believed to have been approximately 12 inches from the die tip (30cm).

Reduction of the temperature of extrusion from 204 degrees Centigrade to 160 degrees Centigrade reduced the amount of smoke and a fibrous nonwoven elastomeric web was successfully produced.

A two inch (5cm) wide transverse direction by five inch (13cm) long machine direction sample was placed lengthwise in an Instron Model 1122 tester having an initial jaw separation of one inch (2.5cm) and elongated to break at a rate of five inches (13cm) per minute. The peak load encountered in elongating the sample to break was measured as 328 grams. The energy at break was measured at 2.01 inch-pounds (0.227J) and the elongation at break, as a percent of the unstretched length of the sample, was measured as 406 percent. The reported peak load and energy at break results were normalized to a 100 gram per square meter value by utilizing the formula identified in footnote one of Table VI.

A different two inch (5cm) wide, transverse direction, by five inch (13cm) long, machine direction, sample of the material obtained in accordance with Example XVIII was then stretched to 75 percent of the elongation at break percent of the prior sample. The sample was placed lengthwise in an Instron Model 1122 tester having an initial jaw separation of one inch (2.5cm) and elongated at a rate of five inches (13cm) per minute. That is, the sample was stretched to 75 percent of 406 percent elongation or about 305 percent. Then the sample was relaxed to an unstretched condition and the procedure was repeated three (3) times. Thereafter, the sample was elongated to break. The results of this test are reported in Table XII, below.

TABLE XII

Stretch No.	Load ¹	Energy ²	% Stretch ³
1	295	1.24 (140)	305%
2	259	0.92 (104)	305%
3	236	0.82 (93)	305%
4	219	0.75 (85)	305%
to break	253	1.29 (146)	420%

Footnotes to Table XII

¹ = in grams, normalized to a 100 gram per square meter sample

² = in inch-pounds (Joules $\times 10^3$) normalized to a 100 gram per square meter sample

³ = as a percent of the unstretched sample. For example, 100 percent means twice the unstretched length of the sample.

Table XII indicates that the fibrous nonwoven elastomeric web of Example XVIII demonstrated satisfactory elongation characteristics but had generally lower tensile strength than comparable materials not containing the Indopol L-14 polybutene.

As a short cut in determining an indication of the ranges over which commercially feasible throughput (extrusion rates) amounts of the KRATON G 1652/L-14 blends could be meltblown, blends of various amounts of the KRATON G 1652 and the L-14 materials were formulated and the meltflow characteristics of each of the blends was determined. The meltflow value of a given blend is important because, generally speaking, meltflow values, as determined by ASTM test procedure D-1238, condition E (190 degrees Centigrade and 2,160 gram load), in excess of 50 grams per capillary per ten (10) minutes tend to indicate that the blend can be meltblown on a commercial scale. The results of these meltflow tests are detailed in Table XIII below.

TABLE XII

Kraton G 1652 ¹	Indopol L-14	Meltflow
60	40	6.75 ³
55	45	15.6 ³
50	50	227 ³
50	50	132 ⁴
50	50	11.7 ⁵
45	55	507 ³

Footnotes for Table XIII.

¹ = percent, by weight.² = percent by weight.³ = ASTM D-1238, Condition E (190°C.; 2,160 gram load).⁴ = same as preceding footnote³ except temperature maintained at 170°C.⁵ = same as preceding footnote⁴ except temperature maintained at 150°C.

The results of Table XIII tend to indicate that the KRATON G 1652/Indopol L-14 blends may be meltblown at commercially feasible throughput rates at temperatures of about 170°C when the blend contains 50 percent, by weight, of the Indopol L-14.

Even further examples were conducted with Table XIV summarizing the variables utilized in Examples XIX through XXIII.

TABLE XIV

Example	19	20	21	22	23
Extruder/Die Arrangement ¹	B3	B3	B3	B3	B3
Material ²	70A/30B	60A/40B	50A/50B	40A/60B	30A/70B
Extrusion Rate ³	0.16	0.31	0.56	0.82	0.94
Extrusion Temperature ⁴	602 (315)	602 (315)	603 (315)	602 (315)	594 (312)
Extrusion Pressure ⁵	208 (1.4)	200 (1.4)	201 (1.4)	198 (1.4)	166 (1.1)
Die Tip Stick-Out ⁶			0.010 (0.25)		
Air Passageway Gap ⁷			0.060 (1.5)		
Air Temperature ⁸	601 (315)	600 (315)	600 (315)	600 (315)	600 (315)
Air Pressure ⁹			2 (14)		
Material Viscosity ¹⁰	677	336	187	126	92
Distance ¹¹					
Die-Tip to Forming Screen			12 (30)		

Footnotes for Table XIV:

¹ = as defined herein² = A = KRATON GX 1657 (Shell)

B = Polyethylene PE Na601 (U.S.I.)

90A/10B = 90 percent, by weight, A blended with 10 percent, by weight, of B

³ = in grams per capillary per minute⁴ = in degrees Fahrenheit (°C)⁵ = in pounds per square inch, gage in the capillaries (MPa)⁶ = negative values indicate recessed die tip arrangement, in inches (mm)⁷ = in inches (mm)⁸ = in degrees Fahrenheit (°C)⁹ = in pounds per square inch, gage (kPa)¹⁰ = in poise¹¹ = in inches, approximate values not actually measured (cm)

In examples 19 through 23, which all utilized extruder/die configuration B3, as defined herein, the temperature of extrusion, extrusion pressure, air temperature, and air pressure were maintained as constant as practical. Accordingly, referring to Table XV the dramatic decrease in the viscosity of blend in the capillaries and the accompanying increase in extrusion (throughput) rates as the percent, by weight, of the polyolefin material is increased is clear.

To further investigate the effects of increasing polyolefin content in the blends on the fibrous nonwoven elastomeric webs formed therefrom the elongation, peak load and energy at break characteristics of samples of the fibrous nonwoven webs formed in examples 19 through 23, were measured by obtaining five (5) samples of each web having a cross machine direction width of two inches (5cm) and a machine direction length of five inches (13cm). Each of the five samples was placed lengthwise in an Instron tensile tester model TM with an initial jaw separation of one (1) inch (2.5cm). Each sample was then stretched at a rate of 5 inches per minute (13cm per minute) to determine the load, in grams, required to elongate the sample to break. These results are reported below in Table XV, below.

TABLE XV

<i>Example</i>	<i>Sample</i>	<i>Basis Weight¹</i>	<i>Tensile²</i>	<i>Energy³</i>	<i>Percent⁴ Elongation</i>	
5						5
19	1	116	1,470	4,940 (123)	663	
19	2	166	1,460	6,605 (165)	525	
19	3	158	1,430	6,670 (166)	675	
19	4	147	1,410	6,510 (162)	688	
10 19	5	—	—	—	—	10
19 Avg ⁵	—	146.86	1,343	6,181 (154)	638	
19 SD ⁶	—	18.6	158	719 (18)	66	
19 N ⁷	—	85.00	777	3,578 (89)	—	
15						15
20	1	63.5	650	2,965 (74)	550	
20	2	63.5	560	2,260 (56)	525	
20	3	63.5	590	2,390 (60)	538	
20	4	66.6	660	2,635 (66)	488	
20 20	5	58.9	540	2,080 (52)	500	20
20 Avg ⁵	—	63.24	600	2,466 (61.4)	520	
20 SD ⁶	—	3.1	48	308 (7.7)	23	
20 N ⁷	—	85.00	806	3,315 (82.6)	—	
25						25
21	1	104	1,130	4,280 (107)	500	
21	2	102	1,050	3,120 (78)	275	
21	3	113	1,340	4,755 (118)	513	
21	4	112	1,040	3,005 (75)	311	
30 21	5	110	1,180	3,970 (99)	463	30
21 Avg ⁵	—	108.19	1,148	3,826 (95.3)	428	
21 SD ⁶	—	4.6	109	673 (16.8)	88	
21 N ⁷	—	85.00	902	3,006 (74.9)	—	
35						35
22	1	155	1,760	4,885 (122)	350	
22	2	155	1,770	5,135 (128)	350	
22	3	143	1,600	4,955 (123)	375	
22	4	144	1,610	4,560 (114)	350	
40 22	5	146	1,650	4,500 (112)	358	40
22 Avg ⁵	—	148.49	1,678	4,807 (120)	355	
22 SD ⁷	—	4.6	73	241 (6.0)	10	
22 N ⁷	—	85.00	961	2,752 (68.6)	—	
45						45
23	1	143	1,520	2,480 (62)	113	
23	2	144	1,600	2,945 (73)	213	
23	3	124	1,420	2,225 (55)	200	
23	4	141	1,640	3,435 (86)	250	
50 23	5	149	1,750	3,290 (82)	225	50
23 Avg ⁵	—	140.12	1,586	2,875 (71.6)	200	
23 SD ⁶	—	7.7	111	462 (11.5)	47	
23 N ⁷	—	85.00	962	1,744 (43.5)	—	
55						55

Footnotes for Table XV:

¹ = in grams per square meter² = in grams per two (2) inch (5cm) sample³ = in inch-grams (Joules $\times 10^3$)⁴ = as a percent of the length of the unstretched sample, that is 100 percent equals twice the length of the original sample⁵ = average⁶ = standard deviation⁷ = values normalized to 85 grams per square meter value

These data generally indicate that the tensile strength of the material increases with increasing amounts of Na601 polyethylene. Further, increasing amounts of polyethylene tend to decrease the elongation at break of the material. However, even at 70 percent, by weight, Na601 polyethylene content is 200 percent elongation, at break is obtained.

5 Another group of samples, that is the following Examples 24 through 30, was formed using a third lot, lot C, of KRATON GX 1657 blended with various amounts of polypropylene materials.

Yet further examples were conducted with Table XVI, below, summarizing the process conditions of Examples XXIV through XXX.

10 TABLE XVI 10

Example	24	25	26	27	28	29	30	
Extruder/Die	B4	B4	B4	B4	B4	B4	B4	
15 Arrangement ¹								15
Material ²	60A/40D	60A/40E	60A/20D/20E	60A/20D/20E	60A/20D/20E	60A/40E	60A/40E	
Extrusion Rate ³	0.33	0.33	0.33	0.33	0.33	0.31	0.31	
Extrusion Temperature ⁴	322	322	323	230	221	161	172	
20 Extrusion Pressure ⁵	265 (1.8)	20 (0.14)	101 (0.7)	190 (1.3)	300+ (2+)	295-451 (2.1-3.1)	155-327 (1.1-2.3)	20
Die Tip Stick-Out ⁶				0.010 (0.25)				
Air Passageway Gap ⁷				0.060 (1.5)				
25 Air Temperature ⁸	337	337	337	337	337	210	213	25
Air Pressure ⁹				2.0 (14)				
Material Viscosity ¹⁰	419	32	159	300	474+	496-758	260-550	
Distance ¹¹				12 (30)				
30 Die-Tip to Forming Screen								30

The following footnotes apply to Table XVI:

- 35 ¹ = as defined herein 35
- ² = A = KRATON GX 1657 (Shell), lot C
D = polypropylene PC-973 (Himont)
E = polypropylene Epolene N-15 wax (Eastman)
90A/10B = 90 percent, by weight, A blended with 10 percent, by weight, of B
- 40 ³ = in grams per capillary per minute 40
- ⁴ = in degrees Centigrade
- ⁵ = in pounds per square inch, gage in the capillaries (MPa)
- ⁶ = negative values indicate recessed die tip arrangement, in inches (mm)
- ⁷ = in inches (mm)
- 45 ⁸ = in degrees Centigrade 45
- ⁹ = in pounds per square inch, gage (kPa)
- ¹⁰ = in poise
- ¹¹ = in inches, approximate values (cm)

50 The elastomeric characteristics of the fibrous nonwoven webs formed in examples 24, 25, 26, 27 and 29 were 50
measured. The testing was accomplished by utilization of an Instron tensile tester model 1122, which elongated
each sample, at a rate of five inches (13cm) per minute, 100 percent, that is 200 percent of the original
unstretched machine direction length and then allowed the sample to return to an unstretched condition. This
procedure was repeated three (3) times and then each sample was elongated to break or tear. Each sample was
55 two inches (5cm) wide (transverse machine direction) by three inches (8cm) long (machine direction) and the 55
initial jaw separation on the tester was set at one inch (2.5cm). The samples were placed lengthwise in the
tester. The data which was obtained is tabulated in Table XVII below.

60 60

65 65

TABLE XVII

Example		Stretch Number	MD Strip Tensile ¹	Energy ²	
5	24	1	4.048	1.72 (194)	5
	24	2	3.168	0.73 (82)	
	24	3	3.155	0.73 (82)	
	24	4	3.223	0.50 (56)	
	24	³ to break (736%)	6.670	19.23 (2.17J)	
10	25 (all data example 25) ⁴	1	2.35	1.05 (119)	10
	25	2	2.13	0.39 (44)	
	25	3	2.05	0.35 (40)	
	25	4	2.00	0.32 (36)	
	25	³ to break (280%)	2.73	2.78 (314)	
15	26 (all data example 26) ⁴	1	2.67	1.20 (136)	15
	26	2	2.57	0.54 (61)	
	26	3	2.52	0.49 (55)	
	26	4	2.47	0.46 (52)	
	26	³ to break (775%)	5.17	14.67 (1.66J)	
20	27	1	1.68	0.66 (75)	20
	27	2	1.62	0.37 (42)	
	27	3	1.58	0.35 (40)	
	27	4	1.55	0.33 (37)	
	27	³ to break (854%)	4.21	11.83 (1.34J)	
25	29	1	0.70	0.23 (26)	25
	29	2	0.64	0.08 (9)	
	29	3	0.61	0.11 (12)	
	29	4	0.61	0.11 (12)	
	29	³ to break (110%)	0.70	0.19 (21)	
30	29	1	0.70	0.23 (26)	30
	29	2	0.64	0.08 (9)	
	29	3	0.61	0.11 (12)	
	29	4	0.61	0.11 (12)	
	29	³ to break (110%)	0.70	0.19 (21)	

35 Footnotes for Table XVII

¹ in pounds per two inch wide sample (5cm) and reported as an average of four (4) replicate measurements unless otherwise stated with the average then being normalized to a 100 gram per square meter material according to the formula reported value = (average value) × $\left(\frac{100}{\text{actual basis weight}} \right)$

² in inch-pounds (Joules × 10³) and reported as an average of four (4) replicate measurements unless otherwise stated with the average then being normalized to a 100 gram per square meter material according to the formula of the immediately preceding footnote 1.

³ as a percentage increase of the length of the original unstretched sample and reported as an average of four (4) replicate measurements unless otherwise stated. For example, 100 percent would equal twice the length of the original unstretched sample.

⁴ average of five (5) replicate samples.

Examples 28, 29 and 30 exemplify the extreme lower limits of using polypropylene materials since the high pressures encountered and the wide fluctuation in the pressures indicate that the polypropylene material was probably beginning to solidify. Thus surging of the blend which would account for the pressure fluctuations would be expected. Specific note should be made of the low viscosity of 32 poise encountered in Example 25.

The nonwoven elastomeric webs of the present invention, whether comprising 100 percent elastomeric fibers or, for example coformed blends of elastomeric and other fibers, find widespread application in providing elasticized fabrics whether used by themselves or bonded to other materials. Potential uses include disposable garments and articles, by which is meant garments and articles designed to be discarded after one or a few uses rather than being repeatedly laundered and reused.

The blends of materials which were formed into elastomeric nonwoven webs in Examples I-XXX may also be extruded and formed into films under appropriate, i.e. effective, elevated temperature and elevated pressure conditions to provide satisfactory elastomeric films. Preferably the material is extruded through the film die at a temperature of at least about 125 degrees Centigrade if polyethylene is utilized as the polyolefin in the blend or at least about 175 degrees Centigrade if a polypropylene is utilized as the polyolefin in the blend, for example at a temperature of from at least about 290 degrees Centigrade to about 345 degrees Centigrade, more specifically from a temperature of from at least about 300 degrees Centigrade to about 335 degrees Centigrade.

The preferred elevated temperatures of extrusion and the presence of the specified polyolefin in the blend reduces the viscosity of the blend, as compared to the viscosity of the pure, i.e. neat, A-B-A' block copolymer, and thus forms the blend into an extrudable composition which can be utilized to form the elastomeric films of the present invention. However, both the block copolymer resins and the polyolefins must be able to sustain the extrusion temperatures utilized by the method of the present invention without undergoing excessive chain scission or excessive thermal or oxidative degradation. In this regard it is believed that the degree of oxidative degradation sustained by the extrudable composition may be reduced by blanketing the raw pellets of the resins utilized with an inert gas prior to their processing by an extruder. The fact that the amount of oxidative degradation which the block copolymer undergoes during extrusion may be reduced by blanketing the raw pellets with an inert gas is generally implied by thermogravimetric analyses of KRATON GX 1657 block copolymer resin which were carried out in air and nitrogen. In these analyses samples of the KRATON GX 1657 block copolymer resin, when heated in air, showed a weight loss beginning at about 307 degrees Centigrade whereas a comparison sample heated in nitrogen showed only a weight loss starting at about 375 degrees Centigrade. It is believed that these results indicate that the effects of oxidative degradation on the sample heated in air could be avoided or diminished by blanketing the raw pellets with an inert or, at least, a non-oxidizing gas.

Referring to Figure 6 which schematically illustrates apparatus for forming an elastomeric film in accordance with the present invention, it can be seen that a blend (not shown) of (a) from at least about 10 percent, by weight, of an A-B-A' block copolymer where A and A' are both thermoplastic polymer endblocks containing a styrenic moiety such as, for example, a poly(vinyl arene) and where B is an elastomeric poly(ethylene-butylene) midblock, with (b) from greater than 0 percent, by weight, to about 90 percent, by weight, of a polyolefin which, when blended with the A-B-A' block copolymer and subjected to an effective combination of elevated temperature and elevated pressure conditions, is extrudable in blended form with the A-B-A' block copolymer, is supplied in, for example, pellet form to a hopper 210 of an extruder 212. The components of the blend may be supplied in pellet or other form. The components (i.e., pellets) may be blanketed with an inert or, at least, non-oxidative gas while in the hopper 210. This is believed to reduce the effects of oxidative degradation on the blend by both reducing the contact of the blend with normal atmosphere while in the hopper 210 and also increasing the likelihood that any gas that is drawn into and through the extruder 212 will be the inert gas as opposed to oxygen-containing normal atmosphere.

The temperature of the blend is elevated within the extruder 212 by a conventional heating arrangement (not shown) to melt the blend and pressure is applied to the blend by the pressure-applying action of a turning screw (not shown), located within the extruder, to form the blend into an extrudable composition. Preferably the blend is heated to a temperature of at least about 125 degrees Centigrade if polyethylene is utilized as the polyolefin in the blend or at least about 175 degrees Centigrade if polypropylene is utilized as the polyolefin in the blend, for example, to a temperature of from at least about 290 degrees Centigrade to about 345 degrees Centigrade, more specifically, to a temperature of from at least about 300 degrees Centigrade to about 335 degrees Centigrade. The combination of elevated temperature and elevated pressure conditions which effect extrusion of the composition will vary over wide ranges. For example, at higher elevated temperatures, lower elevated pressures will result in satisfactory extrusion rates and, at higher elevated pressures of extrusion, lower elevated temperatures will effect satisfactory extrusion rates.

The extrudable composition is then forwarded by the pressure applying action of the turning screw to a film die 214. The rate of rotation of the turning screw is adjusted so that the blend is under at least about 100 pounds per square inch, gage (6.9×10^5 Pa) of pressure in the film die 214. Preferably, the blend is under from about 100 psi, g to about 500 psi, g ($0.7-3.4$ MPa) of pressure in the film die 214. For example the blend may be under from about 200 psi, g to about 350 psi, g of pressure in the film die 214 ($1.3-2$ MPa) more specifically from about 275 psi, g to about 325 psi, g of pressure in the film die 214. ($1.9-2.2$ MPa) The elevated temperature of the extrudable composition is maintained in the film die 214 by a conventional heating arrangement (not shown). The die 214 has a die slot opening 216 which generally extends a distance 218 which is approximately equal to the width of the film 220 which is to be formed by the process. The slot 216 of the die 214 has a gap 222, usually adjustable, which controls the thickness of the molten material 224 which is extruded from the slot 216 of the die 214. After the molten material 224 exits the slot 216 of the die 214 it is cooled by, for example, quenching in a bath of cooling water 226. A wind-up roller 228, which is rotating as indicated by the arrow 230 in Figure 6, collects the final elastomeric film product 220 which has a thickness that is less than the thickness of the freshly extruded molten material 224 due to the fact that the peripheral surface speed of the wind-up roller 228 is adjusted so that it is faster than the speed of extrusion of the molten material 224 from the die 214. As a result of the fact that the peripheral surface speed of the wind-up roller 228 is greater than the speed of extrusion of the molten material 224, the molten material 224 is stretched, that is drawn down, as is known in the art, upon its exit from the slot 216 of the die 214. The drawing down of the molten material 224 generally occurs after extrusion of the molten material 224 from the die 214 and prior to entry of the molten material 224 into the water bath 226 since the water bath 226 will cool and set the molten material 224 at the drawn down film dimensions. The film 220 is transported within the water bath 226 by being passed under a plurality of transport rollers 232 and is then taken up on the roller 228.

Depending upon the rate of drawing down, the extrudable composition can be extruded as the molten material 224 and then formed into elastomeric films 220 having a thickness of not greater than about 25 mils, (0.64mm) preferably having a thickness of not more than about 10 mils (0.25mm) for example, having a thickness of less than about 3 mils. (0.08mm)

Example XXXI

A three component blend including (1) 60 percent, by weight, of an A-B-A' block copolymer having polystyrene "A" and "A'" endblocks and a poly (ethylene-butylene) "B" midblock (obtained from the Shell Chemical Company under the trade designation KRATON GX 1657), (2) 30 percent, by weight, of a polyethylene (obtained from U.S.I. Chemical Company under the trade designation PE Na601) and (3) 10 percent, by weight, of a white concentrate of a colorant blend of 50 percent, by weight, titanium dioxide and 50 percent, by weight, of a polypropylene obtained from Ampacet under the trade designation "White 41171" was blended, at temperatures of from about 140 degrees Centigrade to about 210 degrees Centigrade in a Baker-Perkins compounding extruder arrangement including a twin screw compounding extruder number 60009 and a single screw extruder number 60020. The twin screw extruder was arranged to advance the compounded material to the single screw extruder from which strands of the compounded material were extruded, quenched with water, and chopped into segments to provide pellets of the compounded material.

The pellets were then fed and extruded through a 0.75 inch (19mm) diameter Brabender extruder which had a length/diameter ratio of about 24:1 and had three temperature control zones which were maintained at about 200 degrees Centigrade, about 215 degrees Centigrade and about 225 degrees Centigrade, respectively. After passing through the three temperature control zones, the compounded material was advanced to a film die which had a single temperature control zone that was maintained at about 235 degrees Centigrade and had a die slot of about 4 inches (10cm) in width and which, while no actual measurement was made, is believed to have been set at a gap, that is opening, of between about 25 and about 50 thousandths of an inch. (0.64-1.3mm) The compounded material was extruded through the slot as a molten sheet. The molten sheet was drawn down, that is stretched, by the action of a wind-up roller to reduce its thickness and was then quenched (cooled) by being passed through a bath of cooling water. The thus-formed film was collected on the wind-up roller. Due to the high tackiness of the film it tended to self-adhere and stick together. Therefore, it was collected on the wind-up roller by interposing a sheet of silicone coated release paper between the adjacent film layers.

Example XXXII

A three component blend including (1) 70 percent, by weight, of an A-B-A' block copolymer having polystyrene "A" and "A'" endblocks and a poly (ethylene-butylene) "B" midblock (obtained from the Shell Chemical Company under the trade designation KRATON GX 1657), (2) 20 percent, by weight, of a polyethylene (obtained from U.S.I. Chemical Company under the trade designation PE Na601) and (3) 10 percent, by weight, of a white concentrate of a colorant blend of 50 percent, by weight, titanium dioxide and 50 percent, by weight, of a polypropylene obtained from Ampacet under the trade designation "White 41171" was blended, at temperatures of from about 140 degrees Centigrade to about 210 degrees Centigrade in a Baker-Perkins compounding extruder arrangement including a twin screw compounding extruder number 60009 and a single screw extruder number 60020. The twin screw extruder was arranged to advance the compounded material to the single screw extruder from which strands of the compounded material were extruded, quenched with water, and chopped into segments to provide pellets of the compounded material.

The pellets were then fed and extruded through a 0.75 inch (19mm) diameter Brabender extruder which had a length/diameter ratio of about 24:1 and had three temperature control zones which were maintained at about 200 degrees Centigrade, about 215 degrees Centigrade and about 225 degrees Centigrade, respectively. After passing through the three temperature control zones, the compounded material was advanced to a film die which had a single temperature control zone that was maintained at about 235 degrees Centigrade and had a die slot of about 4 inches (10cm) in width and which, while no actual measurement was made, is believed to have been set at a gap, that is opening, of between about 25 and about 50 thousandths of an inch. The compounded material was extruded through the slot as a molten sheet. The molten sheet was drawn down, that is stretched, by the action of a wind-up roller to reduce its thickness and was then quenched (cooled) by being passed through a bath of water. The thus-formed film was collected on the wind-up roller. Due to the high tackiness of the film it tended to self-adhere and stick together. Therefore, it was collected on the wind-up roller by interposing a sheet of silicone coated release paper between the adjacent film layers.

Films were successfully formed under the conditions stated in Examples XXXI and XXXII. However, during initial trial runs, the films were so tacky that they tended to self-adhere, i.e. stick together, and were not of a highly desirable uniformity as a result of surging of the material through the die. In an early attempt to overcome the surging problem, the procedures of Example XXXI were utilized except that the temperatures of the temperature control zones were each reduced by ten (10) degrees. This reduction in temperature had no observable effect on the surging problem. One modification that was observed as improving the ability to collect the film was to move the wind-up roller closer to the die so that the length of film which was passing through the water quenching (cooling) bath was reduced.

The films formed by the procedures of Examples XXXI and XXXII demonstrated elastomeric characteristics. In order to investigate these elastomeric characteristics in both the machine direction (MD) and cross machine direction (CD or TD) five one inch (2.5cm) wide (TD) by five inch (13cm) long (MD) samples were cut from the film for purposes of measuring the machine direction characteristics and five one inch (2.5cm) wide (MD) by greater than three (3) inches (8cm) long (TD) samples were cut from the film to measure the transverse machine direction characteristics. One inch (2.5cm) wide machine direction (MD) by five inch (13cm) long transverse direction (TD) samples could not be obtained because the width of the die slot and thus the maximum possible width of the film was only four inches. (10cm) Therefore, samples for measuring the

transverse machine direction characteristics of greater than three inches (7.5cm) long but less than four inches (10cm) long were obtained.

Each of the samples was placed lengthwise in an Instron Model 1122 tensile tester, having an initial jaw separation of three inches (7.5cm), and was elongated, stretched, to 50 percent elongation. That is, one and one-half its unstretched length. The load necessary to achieve this degree of elongation was measured and the sample was maintained at 50 percent elongation for one (1) minute and then the load necessary to maintain the 50 percent elongation of the sample was measured. Next, the elongation of the sample was increased to 100 percent, that is, twice the unstretched length of the sample and the load necessary to achieve the 100 percent elongation was measured. The 100 percent elongation of the sample was maintained for one (1) minute and the load necessary to maintain the 100 percent elongation was then measured. Thereafter, the load was removed from the sample for one (1) minute and the percent of permanent deformation present in the sample after one (1) load free minute was measured. The percent of permanent deformation after periods of three (3) and five (5) load free minutes were also measured. Thereafter, the sample was elongated to break and the peak load encountered in elongating the sample to break and the percent of elongation, at break, as a percent of the unstretched length of the sample, were measured. The data obtained is reported below in Table XVIII, below.

TABLE XVIII

Example	Thickness ¹	Load ²				Percent ³ Deformation After One Load Free Minute	Peakload ⁴	Percent ⁵ Elongation At Break
		50% Initial Elongation	50% Elongation (1 min.)	100% Initial Elongation	100% Elongation (1 min.)			
24 MD	1.4	313	253	355	283	17	793	621%
24 TD	1.5	202	142	236	170	20	502	532%
25 MD	1.4	238	195	270	218	12	1,213	700%
25 TD	0.8	100	78	116	92	14	354	608%

Footnotes for Table XVIII

¹ = in mils, average of five replicate measurements

² = in grams, average of five replicate measurements

³ = as a percent of the prestretched sample length, average of five replicate measurements. For example, a 10 percent permanent deformation value means that, after one load-free minute, the sample had contracted to a length of 110 percent of its prestretched sample length.

⁴ = in grams, maximum load encountered in elongating the sample to break, average of five replicate measurements

⁵ = as a percent of the unstretched length of the sample, average of five replicate measurements. For example, a value of 200 percent would mean that the sample broke at a length which was three times its unstretched length.

Generally, the elastomeric films of the present invention may also contain known useful additives such as pigments (such as the "White 41171"), plasticizers, antioxidants and the like in addition to the block copolymer and the polyolefin but these additives will usually be present in minor amounts of generally no more than about 15 percent or less, by weight, of the total weight of the film. Importantly, the formation of films of the invention is achieved without having to utilize materials which must be leached out of or otherwise removed from the films.

CLAIMS

1. An extrudable elastomeric composition comprising:

at least about 10 percent, by weight, of an A-B-A' block copolymer where "A" and "A'" are each a thermoplastic endblock which comprises a styrenic moiety and where "B" is an elastomeric poly (ethylene-butylene) midblock; and

from greater than 0 percent, by weight, up to about 90 percent, by weight, of at least one polyolefin which, when blended with the A-B-A' block copolymer and subjected to an effective combination of elevated temperature and elevated pressure conditions, is adapted to be extruded, in blended form, with the A-B-A' block copolymer.

2. An extrudable composition as claimed in claim 1, wherein the "A" and "A'" endblocks of the block copolymer are selected from the group consisting of polystyrene and polystyrene homologs.

3. An extrudable elastomeric composition as claimed in claim 1 or claim 2, wherein the polyolefin is selected from the group consisting of at least one polymer selected from the group consisting of polyethylene, polypropylene, polybutene, ethylene copolymers, propylene copolymers and butene copolymers.
4. An extrudable elastomeric composition as claimed in claim 3, wherein the polyolefin is polyethylene.
5. An extrudable elastomeric composition as claimed in claim 4, wherein the polyethylene has a density of about 0.903 grams per cubic centimeter. 5
6. An extrudable composition as claimed in claim 5, wherein the polyolefin is polyethylene having a density of about 0.903 grams per cubic centimeter, a Brookfield Viscosity, cP at 150 degrees Centigrade of about 8500 and at 190 degrees Centigrade of about 3300 when measured in accordance with ASTM D 3236, a number average molecular weight (Mn) of about 4,600, a weight average molecular weight (Mw) of about 22,400, a Z average molecular weight (Mz) of about 83,300 and a polydispersity (Mw/Mn) of about 4.87. 10
7. An extrudable composition as claimed in claim 3, wherein the polyolefin is polypropylene having a density of about 0.900 grams per cubic centimeter, a meltflow rate obtained in accordance with ASTM D 1238, Condition L, of about 35 grams per ten minutes, a number average molecular weight (Mn) of about 40,100, a weight average molecular weight (Mw) of about 172,000, a Z average molecular weight of about 674,000 and a polydispersity (Mw/Mn) of about 4.29. 15
8. An extrudable composition as claimed in any preceding claim comprising from at least about 50 percent, by weight, to about 70 percent, by weight, of the A-B-A' block copolymer and from at least about 30 percent, by weight, to about 50 percent, by weight, of the polyolefin.
9. An extrudable elastomeric composition as claimed in any preceding claim, wherein the sum of the molecular weight of the A endblock and the molecular weight of the A' endblock is about 14 percent of the molecular weight of the A-B-A' block copolymer. 20
10. A fibrous nonwoven elastomeric web including microfibers, said microfibers having been formed from an extrudable elastomeric composition as claimed in any preceding claim.
11. An elastomeric web as claimed in claim 10, wherein the microfibers comprise from at least about 20 percent, by weight, to about 95 percent, by weight, of the A-B-A' block copolymer and from at least about 5 percent, by weight, to about 80 percent, by weight, of the polyolefin. 25
12. An elastomeric web as claimed in claim 11, wherein the microfibers comprise from at least about 30 percent, by weight, to about 90 percent, by weight, of the A-B-A' block copolymer and from at least about 10 percent, by weight, to about 70 percent, by weight, of the polyolefin. 30
13. An elastomeric web as claimed in claim 12, wherein the microfibers comprise from at least 50 percent, by weight, to about 90 percent, by weight, of the A-B-A' block copolymer and from at least about 10 percent, by weight, to about 50 percent, by weight, of the polyolefin.
14. An elastomeric web as claimed in claim 13, wherein the microfibers comprise from at least about 50 percent, by weight, to about 70 percent, by weight, of the A-B-A' block copolymer and from at least about 30 percent, by weight, to about 50 percent, by weight, of the polyolefin. 35
15. An elastomeric web as claimed in claim 14, wherein the microfibers comprise about 60 percent, by weight, of the A-B-A' block copolymer and about 40 percent, by weight, of the polyolefin.
16. An elastomeric web as claimed in claim 10, wherein the microfibers comprise from at least about 50 percent, by weight, to about 90 percent, by weight, of an A-B-A' block copolymer where "A" and "A'" are each a thermoplastic polystyrene endblock and where "B" is an elastomeric poly (ethylene-butylene) midblock, and from at least about 10 percent, by weight, to about 50 percent, by weight, of a polyethylene having a Brookfield Viscosity, cP at 150 degrees Centigrade of about 8500 and at 190 degrees Centigrade of about 3300 when measured in accordance with ASTM D 3236 and a density of about 0.903 grams per cubic centimeter which, when blended with the A-B-A' block copolymer and subjected to an effective combination of elevated temperature and elevated pressure conditions, is adapted to be extruded, in blended form, with the A-B-A' block copolymer. 40
17. A process for forming a cohesive fibrous nonwoven elastomeric web from an extrudable composition as claimed in any of claims 1 to 9, said process including the steps of: 45
- 50 subjecting the extrudable composition to a combination of elevated temperature and elevated pressure conditions to effect extrusion of the extrudable composition from a melt blowing die as molten threads; applying a heated pressurized stream of an attenuating gas to the molten threads to attenuate the molten threads to microfibers; and collecting the microfibers as a cohesive fibrous nonwoven elastomeric web. 50
18. A process as claimed in claim 17, wherein the extrudable composition is subjected to an elevated temperature of from at least about 290 degrees Centigrade to about 345 degrees Centigrade to effect extrusion of the extrudable composition from the meltblowing die. 55
19. A process as claimed in claim 18, wherein the extrudable composition is subjected to an elevated temperature of from at least about 300 degrees Centigrade to about 335 degrees Centigrade to effect extrusion of the extrudable composition from the meltblowing die. 60
20. A process as claimed in any of claims 17 to 19, wherein the extrudable composition is extruded through the meltblowing die at a rate of from at least about 0.02 grams per capillary per minute to about 1.7 or more grams per capillary per minute.
21. A process as claimed in claim 20, wherein the extrudable composition is extruded through the meltblowing die at the rate of from at least about 0.1 grams per capillary per minute to about 1.25 grams per 65

capillary per minute.

22. A process as claimed in claim 21, wherein the extrudable composition is extruded from the meltblowing die at a rate of from at least about 0.3 grams per capillary per minute to about 1.1 grams per capillary per minute.

23. A coformed fibrous nonwoven elastomeric web including:

5 at least about 20 percent, by weight, of a fibrous nonwoven elastomeric web of microfibers as claimed in any of claims 10 to 16; and

from greater than 0 percent, by weight, to about 80 percent, by weight, of at least one secondary fiber generally uniformly distributed throughout the fibrous nonwoven elastomeric web.

10 24. A coformed elastomeric web as claimed in claim 23, wherein the secondary fiber comprises from at least about 30 percent, by weight, to about 70 percent, by weight, of the coformed web.

25. A coformed elastomeric web as claimed in claim 24, wherein the secondary fiber comprises from at least about 30 percent, by weight, to about 50 percent, by weight, of the coformed web.

26. A process for forming an elastomeric material from an extrudable composition as claimed in any of claims 1 to 9, said process including the steps of:

15 27. subjecting the extrudable composition to a combination of elevated temperature and elevated pressure conditions to form the extrudable composition into said elastomeric material.

27. An elastomeric film extruded from an extrudable composition as claimed in any of claims 1 to 9.

28. An elastomeric film as claimed in claim 27, comprising from at least about 20 percent, by weight, to about 95 percent, by weight, of the A-B-A' block copolymer and from at least about 5 percent, by weight, to about 80 percent, by weight, of the polyolefin.

29. An elastomeric film as claimed in claim 28, comprising from at least about 30 percent, by weight, to about 90 percent, by weight, of the A-B-A' block copolymer and from at least about 10 percent, by weight, to about 70 percent, by weight, of the polyolefin.

30. An elastomeric film as claimed in claim 29, comprising from at least about 50 percent, by weight, to about 90 percent, by weight, of the A-B-A' block copolymer and from at least about 10 percent, by weight, to about 50 percent, by weight, of the polyolefin.

31. An elastomeric film as claimed in claim 30, comprising from at least about 50 percent, by weight, to about 70 percent, by weight, of the A-B-A' block copolymer and from at least about 30 percent, by weight, to about 50 percent, by weight, of the polyolefin.

30 32. An elastomeric film as claimed in claim 31, comprising about 60 percent, by weight, of the A-B-A' block copolymer and about 40 percent, by weight, of the polyolefin.

33. A process for forming an elastomeric film from an extrudable composition as claimed in any of claims 1 to 9, said process including the steps of:

35 34. subjecting the extrudable composition to a combination of elevated temperature and elevated pressure conditions sufficient to effect extrusion of the extrudable composition from a film die as a molten film; drawing the molten film to reduce the thickness of the molten film; and cooling the molten film by quenching.

40 35. A process as claimed in claim 33, wherein the extrudable composition is subjected to an elevated temperature of from at least about 290 degrees Centigrade to about 345 degrees Centigrade to effect extrusion of the extrudable composition from the film die.

35. A process as claimed in claim 34, wherein the extrudable composition is subjected to an elevated temperature of from at least about 300 degrees Centigrade to about 335 degrees Centigrade to effect extrusion of the extrudable composition from the film die.

45 36. A process as claimed in any of claims 33 to 35, wherein the film is drawn to reduce the thickness of the film to less than about 3 mils (75 microns).